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# Scotia-Fundy Groundfish Survey Trawls

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April 1988

**Canadian Technical Report of Fisheries and Aquatic Sciences No. 1609**

Fisheries and Oceans Pêches et Océans

Canada

89-01968/

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Fisheries and Aquatic Sciences 1609

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This is the one hundred and ninety-seventh Technical Report from
the Biological Station, St. Andrews, N.B.

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Cat. No. Fs-6/1609 ISSN 0706-6457

Correct citation for this publication:

Carrothers, P. J. G. 1988. Scotia-Fundy groundfish survey trawls. Can. Tech. Rep. Fish. Aquat. Sci. 1609: iv + 27 p.

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## ABSTRACT

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Detailed technical specifications are presented for the three standardized otter trawls used for groundfish surveys in the Scotia-Fundy Region of the Canadian Department of Fisheries and Oceans currently and historically, including a set of three drawings (isometric assembly, trawl plan and footrope layout) specifying each trawl and a verbal description of all trawl components. The historical selection of different types of trawl for biological surveys under different circumstances is outlined and the principle particulars of the relevant fisheries research vessels are tabulated. Structural features of the three trawls are discussed and compared with respect to variations in catch results in the light of observed reactions of fish to the fishing process as recorded in the literature.

## RÉSUMÉ

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On présente les cahiers de charge techniques et détaillés concernant les trois chaluts à panneau normalisés qui sont utilisés pour les recencements, actuels et précédents, de poissons de fond dans la région de Scotia-Fundy de Pêches et Océans Canada, y compris une série de trois dessins (assemblage isométrique, plan du chalut et aménagement des ralingues inférieures) pour chaque chalut et une description de tous les éléments des chaluts. On donne un aperçu des différents types de chaluts qui ont été utilisés par le passé pour des relevés biologiques dans diverses circonstances et on dresse un tableau des principales caractéristiques des bateaux de recherche utilisés dans les pêches pertinentes. Les caractéristiques structurales des trois chaluts sont discutées et comparées à la lumière des réactions des poissons à l'activité de pêche, comme il est indiqué dans la documentation.

# HISTORICAL USE OF DIFFERENT TYPES OF GROUNDFISH TRAWL

## YANKEE 41 TRAWL ON "A.T. CAMERON"

When FRV "A.T. Cameron" came into service in 1958, the most widely used trawl in the Atlantic commercial groundfish fishery for a vessel this size was the Yankee 41 trawl made of manila netting. At that time, there was no demand for the standardized surveys of fishable stocks and prerecruits required by the resource management system of today. Rather, the ship was used primarily for biological research, and the results of the basic scientific studies conducted then on such questions as fish-stock identification and distribution, mesh selection, fish abundance and life history assumed an essential role in the subsequent development of regulations to protect the resource.

Soon after "A.T. Cameron" was commissioned, the commercial fisheries began to develop stern trawlers, and synthetic fibres such as nylon, polyester and ultimately the widely used polyethylene made their appearance in netting and cordage. However, for years, "A.T. Cameron" continued to use the manila Yankee 41 trawl, until manila netting became almost impossible to obtain, in an effort to sustain consistent fishing conditions to permit comparable catches from year to year for biological studies.

The Yankee 41 trawl was not used for the "present generation" of Scotia-Fundy groundfish surveys so it is not described in detail here. However, it is very similar to the Yankee 36 trawl, but larger, having an 80-ft (24.4-m) headline and 100-ft (30.5-m) footrope. It normally fished with a typical headline height of about (±10%) 9.2 ft (2.8 m) and a wing spread of about (±5%) 42 ft (12.8 m).

## YANKEE 36 TRAWL ON "E.E. PRINCE" AND "A.T. CAMERON"

FRV "A.T. Cameron" was based in St. John's, Newfoundland and worked primarily on the Grand Banks, spending a third or less of her time in Scotia-Fundy waters. Her design was based on that of a commercial side-trawler and she was best suited for offshore groundfish research. The need was perceived also for a smaller vessel for research more in the southern Gulf of St. Lawrence, Scotian Shelf and Bay of Fundy. Hence, FRV "E.E. Prince" was designed and built specifically for biological research and was commissioned in 1966. She was a stern trawler, in keeping with contemporary trends but, because her deck was too short to accommodate an extended trawl, she was fitted with swinging gantry rather than a ramp at the stern. The gantry system handles the trawl very similarly to a side trawler, but at the stern. The trawl is still fitted with quarter ropes to lift the footrope and close the net, the bellies still must be fleeted over the bulwark, the codend is fitted with a splitting strap and lazy deckie to bring the catch on board and there is an intermediate or lengthening piece of netting between the codend and the aft belly to permit splitting large catches for hauling. However, even with the gantry system, the stern trawler has the advantage over the side trawler that the vessel does not have to be brought around broadside to the wind and down-wind of the net, with the net abeam, during shooting and hauling, to keep the net clear and the warps out of the propellor, and there is no delay knocking the warps out of the towing block, thereby saving time and work and reducing escapement of fish while hauling (Main and Sangster 1983). Both the stern-ramp and the stern-gantry trawler are able to shoot and haul the trawl directly, without delay and without having to change course.

The original intention in the design of the "E.E. Prince" was that she would use the same Yankee 41 trawl as "A.T. Cameron" in an effort to achieve comparable fishing results. However, it soon became obvious that "E.E. Prince" could not handle a trawl this size and that desired towing speeds could not be maintained, particularly against a head wind. The commercially successful Yankee 36 trawl, already standard on the smaller research side trawler "Harengus," was selected as being similar to, though smaller and more manageable than, the Yankee 41 trawl. At the same time, polyethylene was chosen for the wings, square and bellies and nylon for the codend as the contemporary netting materials. The Yankee 36 trawl normally fishes with a typical headline height of about 8.6 ft (2.6 m) and a wing spread of about 35 ft (10.7 m). When it became necessary to conduct standardized groundfish biomass surveys for stock assessment purposes, this Yankee 36 trawl was also put on "A.T. Cameron" only for the Scotia-Fundy surveys (the Yankee 41 trawl remained for Newfoundland surveys) in an effort to achieve results comparable with those from "E.E. Prince," even though this trawl was rather small for "A.T. Cameron."

## ENGEL 145-FT TRAWL ON "LADY HAMMOND"

With the advent of quota control by NAFO and, later, declaration by Canada of jurisdiction over the fisheries to 200 nautical miles offshore, there were quantum jumps in the need for research surveys as a basis for scientific advice in support of discharging Canadian responsibility for proper management of the fishery resource. In partial fulfillment of this need within acceptable time "Gadus Atlantica," a Norwegian, ice-strengthened, commercial, factory, stern-ramp trawler was converted for research purposes and taken on charter in 1977 to operate from St. John's, Newfoundland. She arrived with the Engel, 164-ft, high-lift bottom trawl which she had been using commercially. This type of trawl was also being used successfully in the Canadian commercial fishery so it was adopted as her groundfish survey trawl. Shortly thereafter, a British, commercial, wet-fish, stern-ramp trawler was converted for research purposes and taken on charter as "Lady Hammond" to operate from Halifax, N.S. In keeping with the decision already made concerning the type of trawl to be used for groundfish surveys on "Gadus Atlantica," it was decided to adopt the Engel high-lift trawl also for "Lady Hammond." However, because the latter vessel is smaller, the smaller Engel, 145-ft, high-lift, bottom trawl was specified. This trawl was already being used successfully by the major fishing companies in Nova Scotia. It should be mentioned that the "Gadus Atlantica" has subsequently switched to a 145-ft, Engel, high-lift, bottom trawl which is similar to but differs in detail from the British version described here for "Lady Hammond." An Engel, 145-ft trawl has also been adopted for surveys on FRV "Wilfred Templeman," one of two sister research stern trawlers designed and constructed for DFO and delivered in 1982 but, again, her trawl differs in detail both from that on "Gadus Atlantica" and from the "Lady Hammond" trawl described here. The Engel, 145-ft trawl specified

here was used on "Lady Hammond" for about 1 yr. before being replaced for surveys by the Atlantic Western IIA trawl as outlined in the next section. An Engel, 145-ft, high-lift, bottom trawl normally fishes with a typical headline height of about 18 ft (5.5 m) and a wing spread of about 46 ft (14 m).

## ATLANTIC WESTERN IIA TRAWL ON "LADY HAMMOND" AND "ALFRED NEEDLER"

The Engel, 145-ft trawl could be handled by "Lady Hammond." However, the footrope is longer than the arena on her deck, requiring the wings to be fleeted while hauling. Also, the net is long enough that the bellies had to be fleeted before the codend could be hauled. This extra time and effort for fleeting was acceptable in commercial fishing where the net was towed long enough to fill the codend and the catch capacity of the trawl could be realized. However, the standard survey tow lasts only 30 min. Consequently, the consistently small size of the catches and the relatively high frequency of the tows injected an element of frustration into this extra hauling effort. Also, delays during hauling imposed by the need to fleet the net could permit smaller fish to escape from the net by swimming forward of the codend liner. The objective of the surveys is to obtain representative samples of the indigenous groundfish populations. For this, the samples need not be large; in fact, large catches require subsampling and the scientific processing becomes onerous with consequent susceptibility to sampling bias and dulled vigilance. Therefore, at the suggestion of Capt. Baker, then Master of "Lady Hammond," the Atlantic Western IIA trawl was adopted as the standard groundfish survey trawl for Scotia-Fundy. This trawl was already highly successful in the regional, commercial fishing fleet and could be handled easily on "Lady Hammond." Being a box trawl, it fishes with a good headline height (about 15 ft (4.6 m)) and it has a similar wing spread (about 35 ft (10.7 m)) to the Yankee 36 trawl which had been the standard Scotia-Fundy groundfish survey trawl for years.

Detailed specifications, as presented here, were developed for this trawl in an effort to minimize variations in net construction from year to year and between different suppliers, and hence to minimize gear-induced trends in survey catch results. This Atlantic Western IIA trawl is now the standard, groundfish survey trawl on "Lady Hammond" as well as on "Alfred Needler," sister ship to "Wilfred Templeman."

Even with the trawl standardized, there still remains the problem of catch differences between tows arising from differences in trawl handling, particularly with regard to direction of tow in relation to ocean currents. Wardle (1983, 1984) describes underwater observations of fish being herded toward the path of the net by the "sweeps" (ground warps and lower wing bridles) where smaller fish become tired and pass over the sweeps to freedom before reaching the net. He also describes observations of larger fish swimming with the trawl in the bight of the footrope, sometimes feeding and sometimes swimming for quite prolonged periods (pollock for 15 min), some escaping around the wing lines or over the headline, particularly if many fish are present and become crowded as at lower speeds, and some eventually tiring and turning into the net. The "turnover" of fish in this aggregation swimming ahead of the footrope depends on how quickly individual fish tire and this, in turn, is shown to be a function of temperature, species, fish size and swimming speed. Thus, all other things being equal, the catch composition in survey tows against the current at a given ground speed (which calls for higher swimming speeds) can be expected to contain proportionately more of the larger fish and fewer of the smaller fish than in survey tows with the current at the same ground speed (which calls for slower swimming speeds). Also, it would not be surprising if fish reacted differently to a trawl which approaches them face on than to one which sneaks up on them from behind. Whereas groundfish under the same circumstances tend to head in the same direction in relation to the current, the direction of tow could affect catch composition through selective fish reactions. Further, it has been shown by Carrothers and Foulkes (1972) and repeatedly by others that the trawl headline is higher at slower than at faster speeds of the trawl through the water but that wing spread is steadier. Thus, at a given ground speed, towing against the current results in a lower headline and smaller mouth opening, thereby encountering fewer fish and presenting a stronger stimulus to avoidance action by the fish, than does towing with the current. In addition to fishing differences arising from different directions of tow in relation to the current, fish swimming in the bight of the footrope at the end of a survey tow can easily escape (Main and Sangster 1983), whence the catch composition can be substantially affected by the way the trawl is hauled, particularly during the initial stages. Thus, for surveys, the fishing procedure as well as the trawl construction should be standardized.

Table 1 gives the principal particulars of the different research vessels used for groundfish surveys in the Scotia-Fundy Region to help engender appreciation for the evolution of the trawl designs adopted for this purpose.

## EXPLANATION OF THE TRAWL DRAWINGS

The drawings are the principal vehicle for the detailed technical specifications of the groundfish survey trawls. They are drawn to scale to give the correct impression of trawl size and proportion. Every attempt has been made for these specifications to be definitive, i.e., complete and unambiguous. This is important because the artistic license otherwise exercised by the net builders could result in structural differences between individual nets of the same type from different sources, or from the same source at different times, causing differences in net catchability or selectivity, thereby introducing biases or increasing the variance in survey results.

Abbreviations are identified on the drawings where appropriate. However, they are also summarized in Table 2 for convenient reference.

## ISOMETRIC ASSEMBLY DRAWINGS OF TRAWL RIGGING AND ATTACHMENTS

An isometric assembly drawing of the whole trawl is used to specify the working lines and trawl attachments to afford a clearer pictorial presentation than otherwise of the general shape assumed by each type of trawl while fishing. These drawings are to scale parallel to the three principal axes of the net, viz., horizontal fore and aft, horizontal athwartwise (direct abeam port and starboard) and

Table 1. Principle particulars of research trawlers.

| Vessel name | "A.T. Cameron" | "E.E. Prince" | "Lady Hammond" | "Alfred Needler" |
|---|---|---|---|---|
| Vessel type | Side trawler | Stern gantry | Stern ramp | Stern ramp |
| Length - overall<br>- between perpendiculars | 54.0 m (177 ft)<br>50.9 m (167 ft) | 39.6 m (130 ft)<br>37.2 m (122 ft) | 58.2 m (191 ft)<br>50.9 m (167 ft) | 50.3 m (165 ft)<br>44.1 m (145 ft) |
| Breadth | 9.75 m (32 ft) | 8.23 m (27 ft) | 11.2 m (37 ft) | 11.0 m (36 ft) |
| Depth | 4.88 m (16 ft) | 4.34 m (14 ft) | 7.31 m (24 ft) | 4.5 m (14.8 ft) |
| Gross registered tons | 753 | 406 | 897 | 925 |
| Main engine power<br>speed | 746 kW(1000 BHP)<br>310 RPM | 448 kW(600 BHP)<br>310 RPM | 1840 kW(2500 BHP)<br>500 RPM | 1490 kW(2000 BHP)<br>850 RPM |
| Propellor diameter<br>pitch<br>speed | controllable | 2100 mm(82.7 in.)<br>controllable<br>310 RPM | 2100 mm(82.7 in.)<br>controllable<br>260 RPM | 2200 mm (87 in.)<br>controllable<br>300 RPM |
| Cruising speed | 12.5 knots | 11 knots | 15 knots | 13 knots |

Table 2. Abbreviations used in the drawings.

| | |
|---|---|
| AB | = cut in netting parallel to the mesh bars |
| AN | = cut in netting normal to the course (general direction) of the twines |
| B | = cut of single mesh bars in the cutting cycle |
| CIRC | = circumference (around) |
| COMB | = rope consisting of a combination of wire and fibre (usually manila) yarns laid together |
| DY | = double yarn (twine) used to knit the meshes in netting |
| E | = hanging or joining ratio (ratio of hanging line length to corresponding extended netting length) |
| IPS | = improved plow steel (wire), Grade 110/120 long tons/in² (1770 N/mm²) |
| GALV.ST. | = galvanized steel wire rope |
| m | = metre |
| mm | = millimetre |
| M | = meshes |
| N | = cut, in the cutting cycle for tapering netting, of two adjacent mesh bars, at the side of the same knot, directed in the netting normal to the course of the twines. Also called a point (P) cut |
| P | = point cut (see N) |
| PA | = polyamide (nylon) |
| PE | = polyethylene |
| PES | = polyester |
| PP | = polypropylene |
| Poly | = polyethylene (polythene) |
| R...tex | = resultant linear density (weight per unit length) of twine in tex (g/km) units |
| P&S | = port and starboard (same both sides of net) |
| Ø | = diameter |
| ' | = feet |
| " | = inches |
| ⋈ | = seabed under centre of headline (origin of isometric reference axes) |

vertical. Typical fishing dimensions, such as headline height and wing spread, have been used as summarized in Table 3. Dimensions not parallel to any of the principal axes cannot be scaled directly from the drawings but can be calculated as the vector sum of their three projections parallel to the respective reference axes, if they can be identified.

The names commonly used in the Scotia-Fundy Region for the various rigging lines and trawl components are marked on the isometric drawings. This terminology is not standardized, sometimes differing even between adjacent ports. Table 4 lists on the same line equivalent terms as commonly found in trawl literature from northeastern USA, from the United Kingdom and from FAO for the same trawl component. Sometimes the same term, such as "bridle" or "sweep," is used for different things in different localities, requiring that the intended meaning be deduced from the context or from the dimensions and/or material of the line.

A comparison between the isometric drawings for the three trawls may help to clarify the essential differences between their fishing shapes and hence between their catching efficiency or selectivity, between their catch compositions and between the interpretations of their respective catch results in terms of biomass estimates and stock assessments.

The Yankee 36 trawl is the oldest design, and hence the most traditional. Not only is it the smallest of these three trawls, but also it has proportionately the lowest headline height and the shortest square. This means that it samples only the fish closest to the seabed and it permits easiest escape of fish which tend to rise and swim over the headline when disturbed by the footrope, such as haddock (Main and Sangster 1981b, 1982 and 1983).

The Yankee 36 trawl traditionally has full lower wings, with the netting extending forward to the lower wing bridles. This helps to assure that groundfish in the path of the net are herded into

Table 3. Typical fishing dimensions of the groundfish survey trawls - as used in the isometric drawings.

| | Trawl | | |
|---|---|---|---|
| | Atlantic Western IIA | Yankee 36 | Engel 145 |
| Wing-end spread | 35 ft (10.7 m) | 35 ft (10.7 m) | 46 ft (14.0 m) |
| Door spread | 110 ft (33.6 m) | 120 ft (36.6 m) | 150 ft (45.7 m) |
| Headline height | | | |
| at center | 15 ft ( 4.6 m) | 9 ft ( 2.7 m) | 18 ft ( 5.5 m) |
| at wing tips | 9 ft ( 2.7 m) | 6 ft ( 1.8 m) | 15 ft ( 4.6 m) |
| Overhang of square | 21 ft ( 6.4 m) | 13 ft ( 4.0 m) | 28 ft ( 8.5 m) |
| Depth of footrope bight | 53 ft (16.2 m) | 36 ft (11.0 m) | 57 ft (17.4 m) |
| Depth of headline bight | 32 ft ( 9.8 m) | 23 ft ( 7.0 m) | 29 ft ( 8.8 m) |
| Distance, doors to wings | 224 ft (68.3 m) | 186 ft (56.7 m) | 238 ft (72.5 m) |
| Footrope length | 106 ft (32.3 m) | 80 ft (24.4 m) | 145 ft (44.2 m) |
| Headline length | 75 ft (22.9 m) | 60 ft (18.3 m) | 96 ft (29.3 m) |
| Belly length | 41 ft (12.5 m) | 30 ft ( 9.0 m) | 45 ft (13.5 m) |
| Used for surveys on | "Lady Hammond" "Alfred Needler" | "A.T. Cameron" "E.E. Prince" | "Lady Hammond" |

Table 4. Equivalent trawl terms.

| Scotia-Fundy | USA | UK | FAO |
|---|---|---|---|
| Headline | Headrope | Headline | Headline |
| Wing lines | Jib lines | Wing lines | Wing-end lines |
| Bolsh line | Hanging line | Bolsh or balch line | Bolch or hanging line |
| Fishing line | Fish line | Fishing line | Fishing line |
| Footrope | Footrope or sweep | Bobbin wire | Ground rope |
| Wing bridles | Wing legs | Headline bridle and tow or toe leg | Spreading wires |
| Ground warps | Ground wires | Cables or bridles | Sweep lines |
| Door legs | Trawl door back straps | Back straps | Backstraps |
| Pennants | Idler | Independent piece | Pennants |
| Belly lines | Belly lines | Belly-lines | Lastridge lines |
| Rib lines | Gore lines | Lastridge lines | Lastridge lines |
| Codline | Codend rope | Codline | Draw rope |
| Quarter ropes | Quarter ropes | Quarter ropes | Quarter ropes |
| Quarter-rope stops | Quarter-rope straps | --- | --- |
| Quarter-rope beckets | Quarter-rope beckets | Headline beckets | Beckets |
| Quarter-rope back straps | Quarter-rope chains | Quarter strap | Backstrops |
| Splitting strap | Splitting strap | Double bag becket | Lifting strop |
| Lazy deckie | Haul-up line | Hauling leg or pork or poke line | Lazyline |
| Doors | Trawl doors | Otter boards | Trawl boards |

the net and captured. However, these areas of the net are very susceptible to damage by the sea bed, and netting variously torn there at different times contributes to variability in catch results as a consequence of fish escaping in unknown quantities through the torn netting. Fish have been observed seeking irregularities in netting for escape (Wardle 1983) so it is possible that more fish escape through a hole torn in lower wing netting, which provides visual stimulus, than if the netting were not there at all and the fish were being guided passively by the lines alone.

Both the Engel and the Atlantic Western survey trawls have cut-back lower wings, in keeping with current practice in commercial fishing where any extra catch afforded by full lower wings is not considered worth the extra time, effort and cost required to fit and repair the netting. However, with both these trawls, as evidenced by the bights of their respective footropes being relatively deep in relation to their spreads, the herding action of the netting-free, forward sections of the footrope is enhanced by operating them at a smaller angle to the direction of tow than is usual with the Yankee trawl. Wardle (1983, 1984) reports that under some conditions netting in the fore part of the trawl exhibits insufficient contrast to be visible, particularly when viewed horizontally and particularly in the presence of sand clouds in the wakes of the doors. Then, this netting may as well not be present and, instead, the trawl frame lines (in this case the footrope and wing lines) and the overhanging, silhouetted, upper wing netting depended upon to herd the fish, requiring that they display good visual contrast and are in a region of the trawl where the fish are not crowded and reaction distance is adequate. Herding in this open, lower-wing area depends on visual stimuli, but Wardle (1984) reports that, even at night, the deck lights on the vessel can illuminate the gear "hundreds of metres away" in the water sufficiently for this stimulus. Also, bioluminescence, when present, plays a part in herding fish into the net. Wardle (1984) also states that longer trawls (Atlantic Western IIA) catch more of the fish they encounter than do shorter ones (Yankee 36) because the codend is further, and often invisible, from the footrope, with the result that tiring fish tend to seek it as an avenue of escape as though it were a hole in the net. He suggests that the length of the net be twice the visible range (whatever that may be) and that the codend be a low-contrast color such as grey (dirty nylon) or orange (polyethylene). In the same vein, he states that larger trawls (Engel 145-ft) catch proportionately more of the fish they encounter than do smaller trawls because the larger dimensions result in the trawl being less visible and hence a lower stimulus to avoidance reaction by the fish.

The original design of the Atlantic Western IIA trawl calls for removable wedges of netting mounted on lines such that they can be affixed quickly to the wing lines and forward sections of the fishing line to close these "lower wing end" areas while fishing on smooth grounds. These wedges are virtually never used commercially, but perhaps should be considered when surveying flatfish.

Whereas both the Engel and Atlantic Western trawls depend more than does the Yankee trawl on the fish being herded voluntarily, it is important that they not be fitted with over-size doors and that the doors not be set at too great an angle of incidence. If the doors spread too far apart, not only is the herding angle of the ground warps, wing bridles and the netting-free end-sections of the footrope increased and less effective by requiring the fish to swim faster (Wardle 1983), but also the dust clouds raised by the doors pass outside the wing-ends and their herding action (Wardle 1984) is wasted by fish escaping between the dust clouds and the net. The angle at which the dust clouds approach the net from the doors varies with the type of door, but, with the flat doors and V-doors specified for these survey trawls, commercial experience and underwater observations of fish reactions (Main and Sangster 1981a) indicate that the angle of incidence of the ground warps to the direction of tow should be not more than 15° and preferably closer to 12°.

Related to this, the spread induced by any given set of doors depends on the type of seabed. Main and Sangster (1979) report that flat, rectangular doors, as used on the Yankee 36 and Atlantic Western IIA survey trawls, gave the least decrease (5%) in door spread on hard ground as compared with sand bottom, V-doors as used on FRV "E.E. Prince" since October 1985 gave somewhat more decrease (13%), but the polyvalent doors as used on the Engel trawl gave the most decrease (25%), probably affecting the relative catch rate with these doors on the two types of seabed. The polyvalent doors also made lightest contact with the seabed and generated the smallest dust cloud which passed outside the trawl wings (Main and Sangster 1981a), probably with less effective herding action than by the other types of door.

The importance of the effect on catch composition of this selective herding action in the fore parts of the trawl, from the trawl doors to the bosom of the footrope, should not be underestimated. Harden Jones et al. (1977), using a sector-scanning echo sounder to observe the reaction to a Granton trawl of plaice fitted with transponding acoustic tags, report that only 61 ± 10% of the fish in the path of the net itself (between wing tips) and 22 ± 10% of those lying between the trawl doors and the wing ends were caught. These figures would vary with different fish species, trawl types and fishing conditions, but they indicate the order of magnitude of herding and escape (40-70%) ahead of the gear. This also puts into the question the use of wing spread in the areal expansion of survey catch results, particularly from the survey trawls with cut-back lower wings. Placing the doors at the wing tips (as was originally done commercially) in order to avoid variable herding action by the wing bridles and ground warps should not be entertained. Commercial experience has demonstrated that this substantially reduces the catch, and Wardle (1984) reports that doors at the wing tips are often both visible at once, effectively discouraging the fish in the path of the net from entering and thereby disqualifying this configuration as a quantitative sampling tool.

Another major way in which the Yankee survey trawl differs from the others is that it is rigged for fishing from a side trawler ("A.T. Cameron") or from a gantry stern trawler ("E.E. Prince"). This requires the fitting of quarter ropes, lazy deckie and splitting strap and associated appurtenances for lifting the footrope and catch, but which should not affect the fish-capture characteristics of the trawl (Stewart and Robertson 1985). However, it also requires a lengthening piece or intermediate of

netting between the aft belly and the codend so that large catches can be split in the water alongside the vessel and brought on board a part at a time. The intermediate tends to neck down while fishing, particularly if there is a catch in the codend (Wardle 1984), which could affect passage of fish back into the net. But, more important, the presence of the intermediate could affect the escapement of fish after they have been caught. The liner for retaining smaller fish specimens extends through both the codend and the intermediate of the Yankee 36 survey trawl. The mesh size for the codend liner was selected to retain all desired specimens, but a larger mesh size was selected for the liner in the intermediate to permit better passage of water and hence easier entry of fish into the codend, with the assumption that only larger fish specimens would move forward into the intermediate and be retained by this larger-mesh liner when the catch has to be split for hauling. The forward end of the intermediate should be on the rail while the catch is being split and taken on board so that no escapement through the unlined bellies is expected during this procedure.

The codends on the Atlantic Western and Engel survey trawls have been made relatively short and the lengthening piece omitted so that the whole catch can be hauled directly and expeditiously up the ramp in the codend with minimum fleeting of the net. However, it is possible for fish to swim forward in the codend while still in the water, particularly at lower hauling speeds. Therefore, in both these nets, the liner is carried forward to include the aft belly. As in the Yankee 36 survey trawl, the smallest mesh liner is restricted to the aft end of the codend where the smallest fish specimens are expected to arrive and remain, while the forward parts of the liner are larger mesh for easier flow of water out of the codend and easier passage of fish through to the back of the codend.

In all these trawls, the codend liner imposes a resistance to the flow of water. This causes a build-up of pressure in the codend and increased flow of water through the bellies immediately ahead of the lined section. To what extent this increased pressure and flow causes these bellies to balloon, their meshes to open, and fish to escape through the netting at this point is not known. According to Wardle (1984) fish going back in the net voluntarily keep clear of the netting and touch becomes a stimulus creating panic only when the fish become crowded as they proceed into the taper. He suggests that the mesh should be small enough to physically retain the fish where the net diameter is less than 5-10 m. Thus, the bulged netting and open meshes immediately ahead of the liner caused by hydrodynamic resistance of the liner is probably a factor in the selectivity of the gear which is different for the three trawls and which varies according to the way the gear is fished and handled.

## TRAWL PLANS OF NETTING PANELS AND MOUNTING LINES

The trawl plans are drawn according to National Standard of Canada CAN2-55.1-M85, "Fishing Yarns, Netting and Nets" (CGSB 1985) and in keeping with the principles developed by the Food and Agriculture Organization of the United Nations (FAO) for their catalogues of fishing gear designs (FAO 1972; Nédélec 1975).

The netting panels are drawn to scale, extended measure in depth (fore and aft in these nets) and at hanging ratio E = 0.5 (one-half extended measure) in width (athwartwise), and are juxtaposed in the manner of assembly into the net. The strict adherence to E = 0.5 results in some steps between adjacent netting panels at the sides of the netting drawings which do not occur in the assembled net, where the longer edge is at relatively less and the shorter edge more than E = 0.5. The magnitude of the step is an indication of the degree of gathering and opening of the meshes at the join. The size of each netting panel in numbers of meshes in width and depth is given. Taper cuts are identified according to International Standard ISO 1532, "Fishing nets - Cutting knotted netting to shape (tapering)" and to the above Canadian Standard. "B" designates a bar cut or cut through a single mesh bar at a knot. "AB" designates all bar cuts or a cut diagonally across the netting following a straight row of sequential knots. "P" designates a point cut and "N" designates a normal cut, alternative names for the same thing, being a cut through both (two) mesh bars at the side of the same knot in the direction in the netting across or normal to the course (general direction) of the netting yarns. "AP" designates all point cuts or a cut directly across the strip of netting following a straight row of knots, opposite in each mesh, normal or at right angles to the netting selvedge and to the course of the netting yarns. Each taper is designated by the number of each type of cut in its cutting cycle, as illustrated for the Atlantic Western IIA trawl.

Mesh sizes are given in extended measure (twine straight but not stretched under tension), either as length (between centers of opposite knots) or as opening (between inner faces of opposite knots) as indicated, and the estimated extended length of each netting panel is given approximately in parentheses.

The twine sizes are designated by their linear density (mass per unit length) given in resultant tex (grams mass per kilometre length of finished twine), in accord with national and international standards even though this system has not been widely adopted by the netting industry, because this designation can be applied uniformly to all types of twine. For heavier twines, the resultant linear density is sometimes given in kilotex (ktex = kg/km = g/m). The more commonly used twine runnage is found in yd/lb by dividing the resultant tex into 496,055 or in m/kg by dividing it into 1,000,000.

Commercial twine designations are not used here partly because twines of the same trade designation can differ quite considerably in size between different suppliers. As a case in point, Table 5 gives the range of linear densities for braided polyethylene and for braided nylon trawl twines of the same nominal "diameters" as reported by different manufacturers. For example, a "2 mm" braided nylon twine from one manufacturer is twice as heavy as that from another. A corresponding variation in strength, visibility, hydrodynamic resistance, etc., can be expected within each commercial twine size. It is more difficult to make a similar comparison for twisted or laid trawl twines because the commercial numbering systems used by different manufacturers are sometimes quite different. By the same token, it is often not possible to specify the size of laid twines by trade number without implicitly specifying the brand; hence, trade numbers are not used here.

Table 5. Linear densities of braided trawl twines.

| Nominal diameter (mm) | Braided polyethylene | Braided nylon |
|---|---|---|
| 2 | | R1753 tex - R3350 tex |
| 2.5 | R2760 tex - R2780 tex | 2850 - 3570 |
| 3 | 3670 - 3700 | 3750 - 6900 |
| 3.5 | 4390 - 4440 | 6100 - 7290 |
| 4 | 4650 - 5950 | 6610 - 8700 |
| 4.5 | 5980 - 6400 | |
| 5 | 7400 - 8150 | 11000 - 11820 |
| 5.5 | 8950 - 10150 | 13550 |
| 6 | | 11020 - 17720 |

The codend liners are drawn with their leading edge aligned with the point of attachment to the bellies.

The mounting lines are drawn to scale in length beside the edge of the netting which is attached to them. They are identified by nominal diameter, length and material. All lengths include any eye splices.

These trawl plans give the detailed technical specifications for the construction of the net. It should be possible with them for different suppliers to provide the same trawl or, failing that, to show the supplier where he has failed to comply with the specifications. Deviations from these specifications should not be condoned; otherwise, trawl construction will vary between trawls, with consequent differences in catch results as damaged or worn trawls are replaced, thus increasing variance within surveys and bias between surveys.

## FOOTROPE LAYOUTS

The footropes and associated bobbin gear are drawn to scale and are laid out in detail to avoid variations in assembly which would probably cause variations in herding action and catch selectivity by fish avoidance while towing.

All these survey trawls are fitted with rubber bobbins. These are noticeably heavier in the water than are the more traditional steel bobbins often used in the commercial fisheries. They keep the footrope more firmly on the seabed, particularly under rough conditions and when towing up a slope, and should allow fewer fish to escape under the footrope, as cod for example are prone to do (Main and Sangster 1981b, 1982), than would steel bobbins of the same diameter. However, because of their weight, they are more prone to dig into muddy substrate, with consequent disruption of towing and possible gear damage. The spherical bobbins in the newer trawl designs should be less subject to this than the flat rollers on the Yankee 36. Other advantages of the rubber bobbins over steel are that they are less noisy while being brought on board, particularly on a side-trawler or stern-gantry trawler where the footrope is dropped on the deck, and that they do not develop leaks and become waterlogged, as may steel bobbins with consequent change in fishing characteristics and impaired hauling.

The footrope on the Yankee 36 survey trawl is made of wire rope in accord with traditional practice. By contrast, the footrope of the Atlantic Western IIA trawl and the forward sections of the footrope on the Engel trawl are made of alloy chain in keeping with contemporary commercial practice. The chain provides not only more weight but also more flexibility to afford better contact of the footrope with the seabed and, hopefully, better herding of the fish.

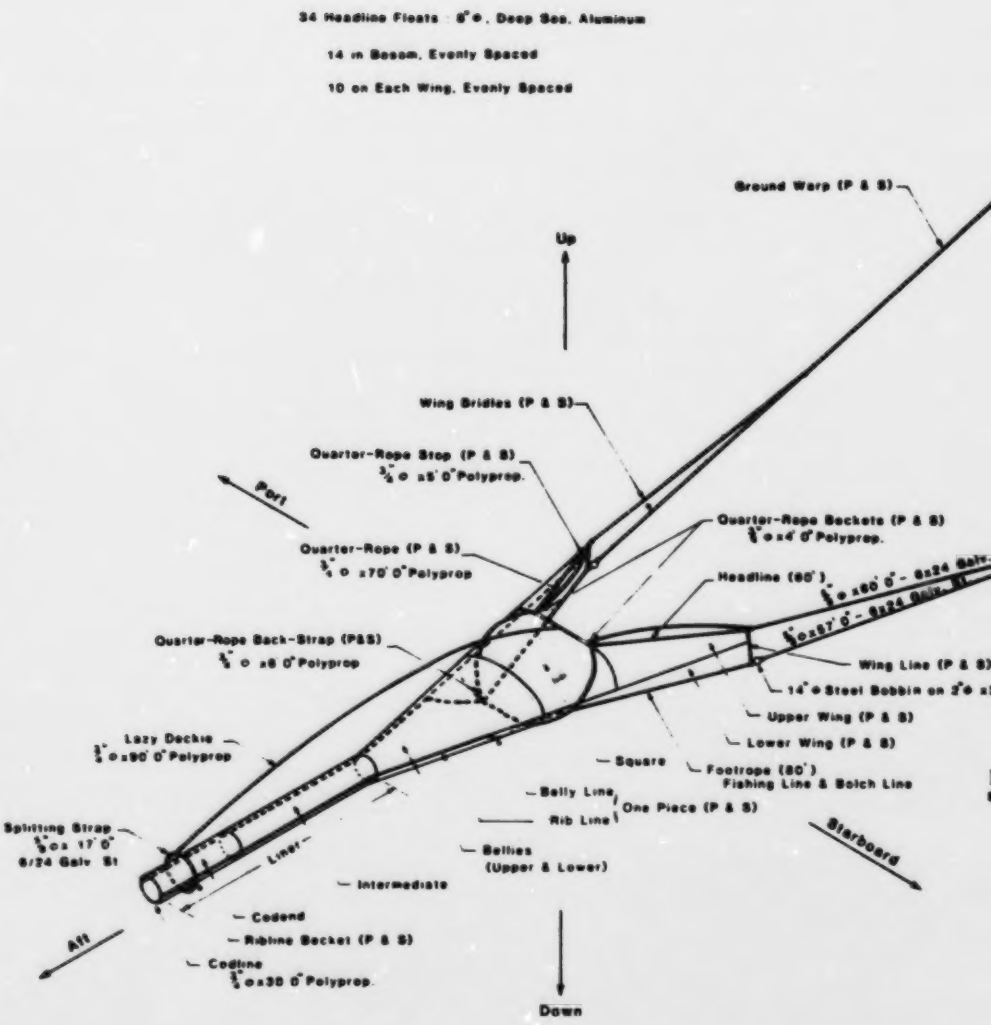
The toggle chains between the fishing line and the footrope are slightly shorter in the bosom of the Yankee 36 trawl than in the other trawls. However, this probably has negligible effect on the escapement of fish under the fishing line in this area because these toggle chains are usually nearly horizontal while fishing. Also, in commercial Atlantic Western IIA trawls, the forward sections of the fishing line are often omitted when there is no intention of using the optional wedges of netting under the flying wings. These sections of the fishing line in the survey trawl should not affect herding in these areas either.

Standard survey procedure in the Scotia-Fundy Region is to rig these trawls the same for all tows in a given survey and for all surveys from year to year, using that same trawl regardless of fishing conditions. Earlier ICES survey reports indicate that trawl rigging was adapted for best operation under each different fishing condition, although recently there have been efforts to standardize the gear between countries. However, this constant rigging means that the rigging selected must be sufficiently rugged for the trawl to withstand bad fishing conditions reasonably well. Thus, the heavy bobbin gear required for fishing rough grounds holds the footrope and fishing line off the seabed while fishing smooth grounds, providing an escape route for species such as skate and cod which tend to go under the net (Wardle 1984). For example, Parrish (1951) in a comparison between the Lowestoft and Aberdeen research trawls reports that the former, rigged primarily for flatfish, caught ten times as many plaice and thirteen times as many dabs as the latter, rigged primarily for roundfish, when used on flatfish grounds. The bobbins in the bosom and bunts of the Yankee 36 trawl are noticeably smaller than in the other two trawls. Also, there are no bobbins under the wings of the Yankee 36 trawl, allowing the footrope to touch the seabed throughout the length in these forward sections. Thus, on smooth grounds, this trawl can be expected to sample bottom-hugging specimens more completely than would the other two trawls. For species-specific surveys under these conditions, it may be worth considering rigging the survey trawl specially for smooth sea-bed, or even using other gear such as a seine net (Danish or Scottish, not purse). For example, Maine and Sangster (1983) report different observed reactions of haddock and pollock to a trawl rigged with a "grass" footrope compared with a trawl rigged with bobbins, and Margetts (1949) reports that, under certain conditions, a seine-netter can outfish an otter trawler on both plaice and haddock.

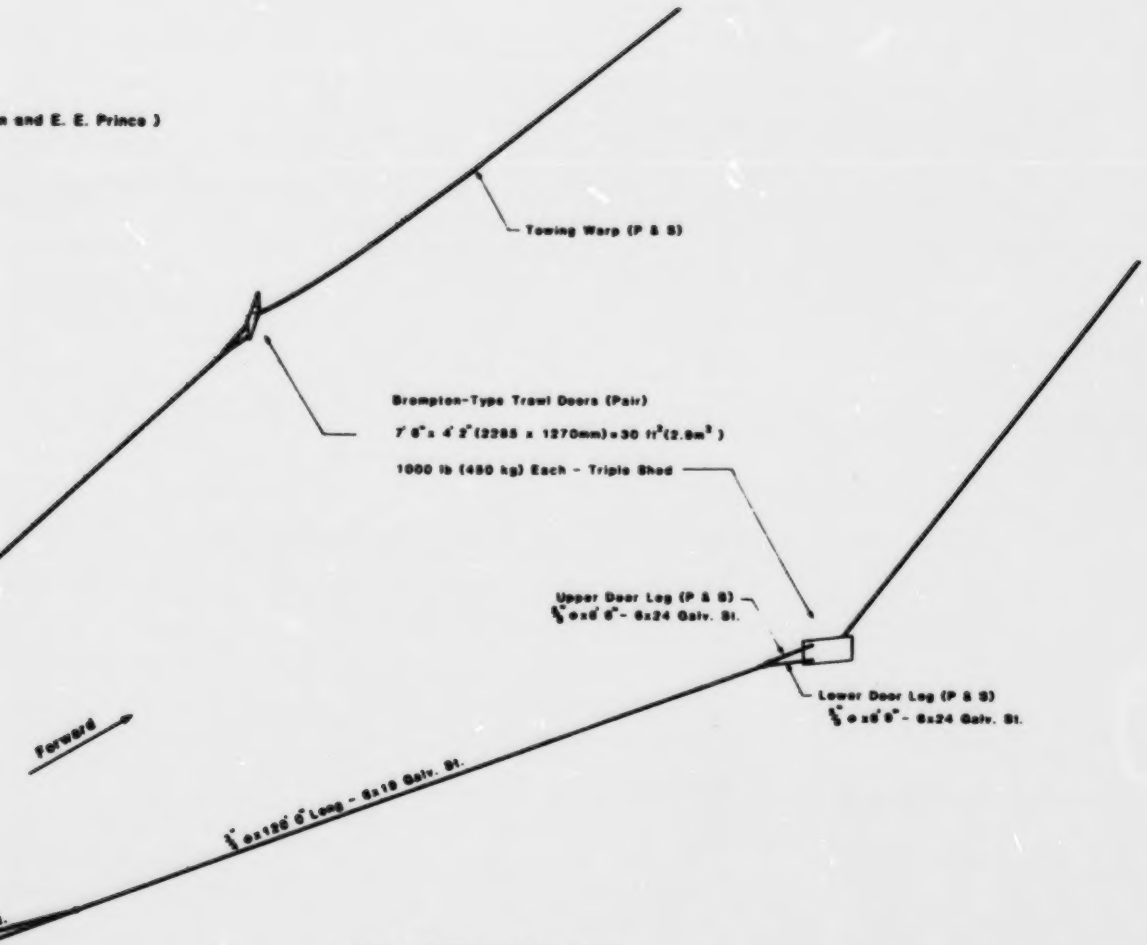
# DETAILED SPECIFICATIONS FOR THE SURVEY TRAWLS

## Yankee 36, Standard, Groundfish Survey Trawl ( A. T. Cam

## - Isometric Assembly

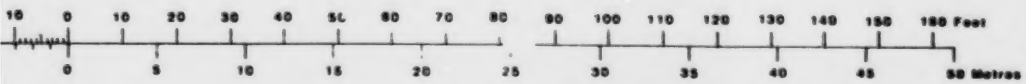


n and E. E. Prince )


Towing Warp (P & S)
Brompton-Type Trawl Doors (Pair)
7' 6" x 4' 2" (2285 x 1270mm) • 30 ft² (2.8m²)
1000 lb (450 kg) Each - Triple Shod
Upper Door Leg (P & S)
⅝" ø x 6' 6" - 6x24 Galv. St.
Lower Door Leg (P & S)
⅝" ø x 6' 6" - 6x24 Galv. St.
Forward
⅝" ø x 120' 0" Long - 6x19 Galv. St.

All Line Lengths Include Eye Splices

Long Steel Spindle (P & S)




(P & S) = Port and Starboard (Two Pieces-Same Both Sides of Net)

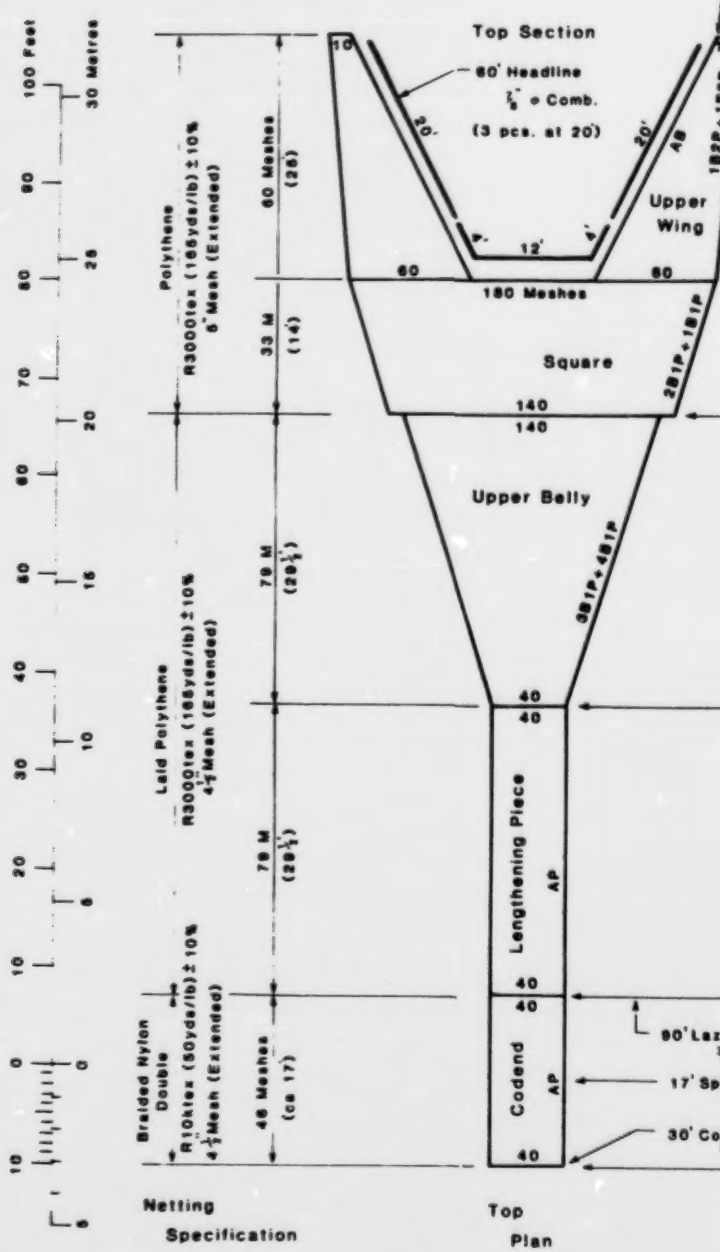
ø = Diameter

Galv. St. = Galvanized, Preformed, Improved Plow Steel, Fibre Core, Wire Rope

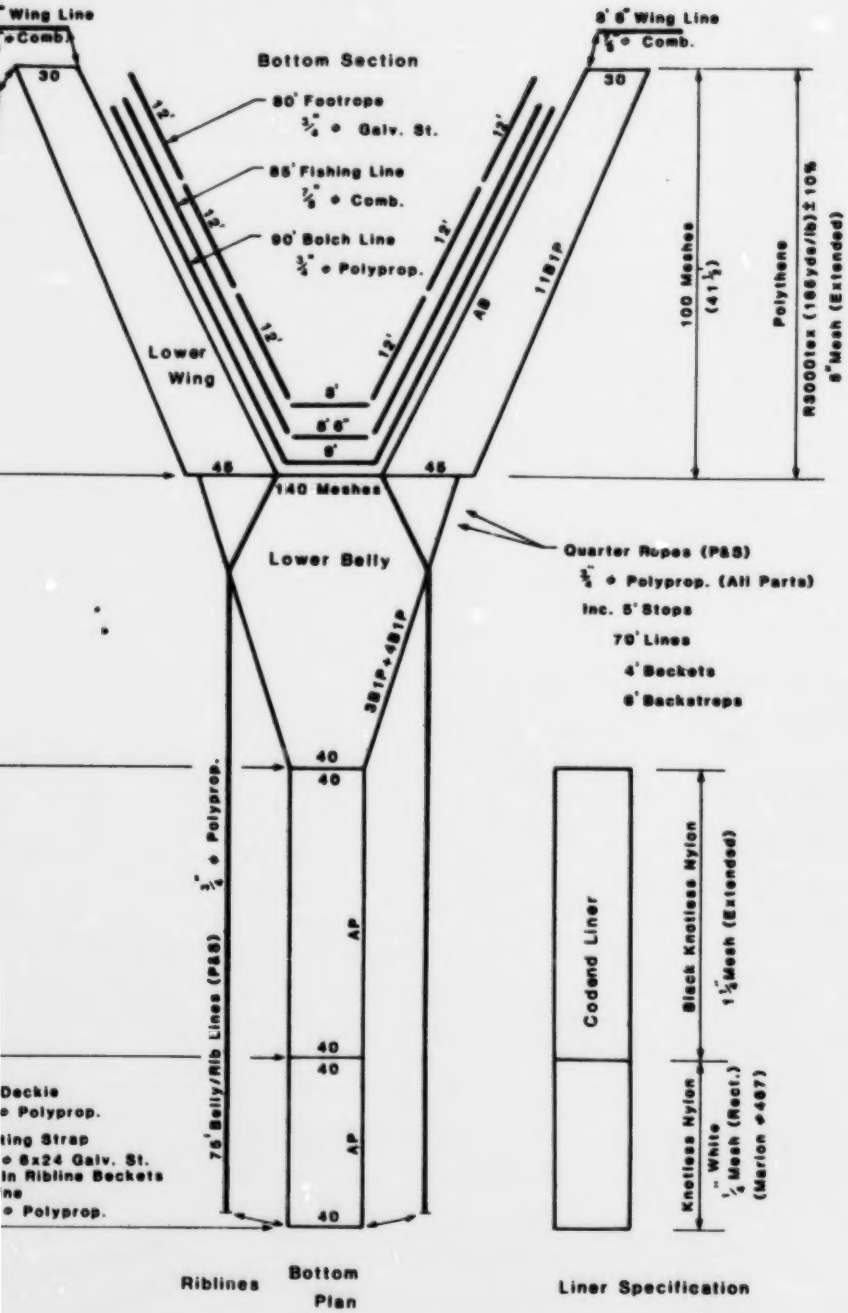
Polyprop. = Polypropylene, Medium-Laid, Filament Rope

⟷ = Sea Bed Under Headline Centre

# Yankee 36 Groundfish Survey Trawl
## Trawl Plan of Netting and Frame Lines

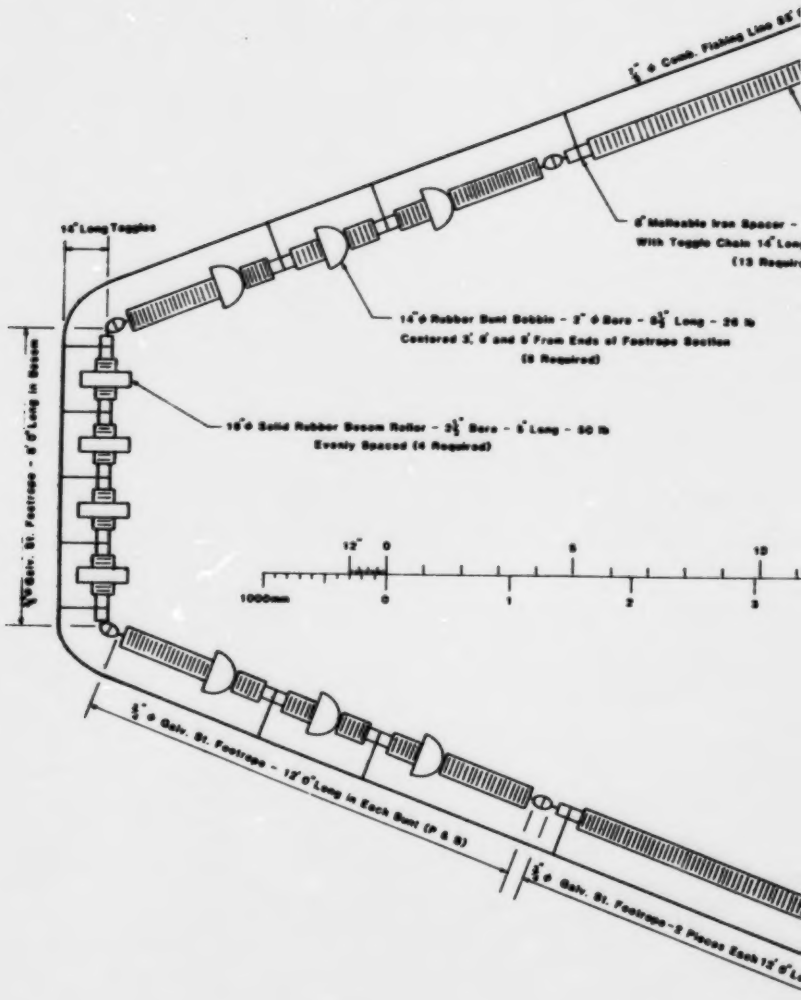


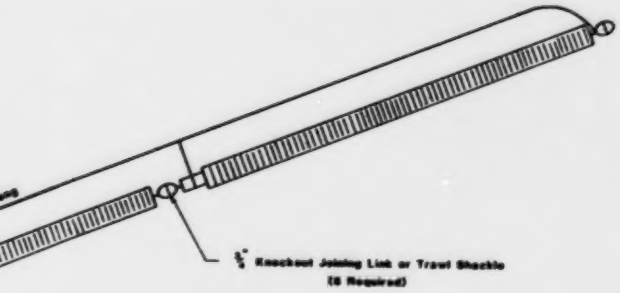
(A.T. Cameron and E.E. Prince)



## Yankee 36 Groundfish Survey Trawl

## Footrope and Fishing Line

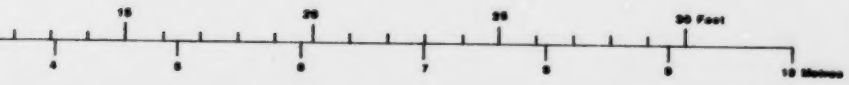





Rubber Footrope Discs – Hole
(To Fill Footrope)

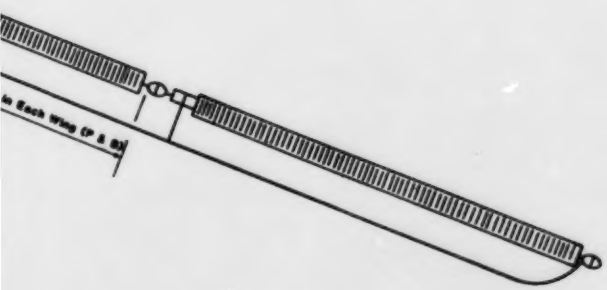
Bore
Spacer g – 17 lb

P & St = Port and Starboard
= Diameter
Galv. St. = Galvanized Steel
Comb. = Combination (Galvanized Steel Wire and Fibre)




All Wire Rope is 6x19 Galvanized, Preformed,
Improved Plow Steel (ISO Tensile Grade 1770 N/mm$^2$), Fibre Core

All Line Lengths include Eye Splices



YANKEE 36, TWO-SEAM, SURVEY TRAWL

Netting Panels:

| Part name | No. of pieces | Material | Twine weight | Mesh length (extended) | Number of meshes Wide Fore | Wide Aft | Deep | Taper cycle |
|---|---|---|---|---|---|---|---|---|
| Upper wings | 2 | Twisted polyethylene | R3.0 ktex | 5" (130 mm) | 10 | 60 | 60 | AB at headline 1B2P + 1B3P at ribline |
| Square | 1 | " | " | " | 180 | 140 | 33 | 2B1P + 1B1P both ribs |
| Lower wings | 2 | " | " | " | 30 | 45 | 100 | AB at bolchline 11B1P at ribline |
| Bellies | 2 | " | " | 4½" (115 mm) | 140 | 40 | 79 | 3B1P + 4B1P both ribs |
| Intermediate | 2 | " | " | " | 40 | 40 | 79 | AP both ribs |
| Codend | 2 | Braided nylon | Double R10 ktex | " | 40 | 40 | 46 | AP both ribs |
| Intermediate liner | 1 | Knotless nylon | R650 tex | 1¼" (32 mm) | Throughout intermediate | | | AP both ribs |
| Codend liner | 1 | " | - | ¼" rect. | Throughout codend | | | Square (Marion #467) |

Frame lines

Note: All line lengths are spliced lengths.

Headline: 3 pieces 7/8 in. (22 mm) diameter combination (wire and manila) rope each 20 ft 0 in. (6.10 m) spliced length, 60 ft 0 in. (18.30 m) total length.

Wing Lines: 2 pieces 7/8 in. (22 mm) diameter combination rope each 8 ft 6 in. (2.59 m) long extending in one piece over both upper and lower wing ends port and starboard (P&S).

Bolch Line: 1 piece 3/4 in. (20 mm) diameter polypropylene rope 90 ft 0 in. (27.43 m) long on the netting along the lower edge of the trawl mouth (9 ft in bosom).

Fishing Line: 3 pieces 7/8 in. (22 mm) diameter combination rope, one 8 ft 6 in. (2.59 m) long in bosom and two each 38 ft 3 in. (11.66 m) on the lower wings P&S, 85 ft 0 in. (25.91 m) total length.

Footrope: 7 pieces 3/4 in. (20 mm) diameter galvanized, 6 x 19, preformed, improved plow steel (IPS), fibre core wire rope, one 8 ft 0 in. (2.44 m) long in bosom and six each 12 ft 0 in. (3.66 m) long, three on each lower wing P&S, 80 ft (24.4 m) total length.

Belly and Rib Lines: 2 pieces 3/4 in. (20 mm) diameter polypropylene rope each 75 ft 0 in. (22.86 m) long extending in one piece from the footrope quarter to the codline P&S.

Codline: 1 piece 3/4 in. (20 mm) diameter polypropylene rope 30 ft 0 in. (9.14 m) long.

Working Lines

Quarter Ropes (Q-R): 2 pieces 3/4 in. (20 mm) diameter laid polypropylene rope each 70 ft 0 in. (21.34 m) long P&S.

Q-R Backstraps: 2 pieces 3/4 in. (20 mm) diameter polypropylene rope each 6 ft 0 in. (1.83 m) long set in the shackle at the footrope quarter P&S.

Q-R Stops: 2 pieces 3/4 in. (20 mm) diameter polypropylene rope each 5 ft 0 in. (1.52 m) long set on the headline above the points where it comes to the rail P&S.

Q-R Beckets: 2 pieces 3/4 in. (20 mm) diameter polypropylene rope each 4 ft 0 in. (1.22 m) long set across the quarter of the headline P&S.

Lazy Deckie: 1 piece 3/4 in. (20 mm) diameter polypropylene rope 90 ft 0 in. (27.43 m) long set on the hauling end of the splitting strap.

Splitting Strap: 1 piece 5/8 in. (16 mm) diameter, galvanized, 6 x 24, preformed, IPS, fibre core, wire rope, 17 ft 0 in. (5.18 m) long in ribline beckets set 6 ft 0 in. (1.8 m) forward of the codline.

Running Lines

Upper Wing Bridles: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 24, preformed, IPS, fibre core, wire rope, each 60 ft 0 in. (17.37 m) spliced length, P&S.

YANKEE 36 (cont'd)

Lower Wing Bridles: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 24, preformed, IPS, fibre core, wire rope, each 57 ft 0 in. (17.37 m) long, P&S.

Ground Warps: 2 pieces 3/4 in. (20 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, each 120 ft 0 in. (36.58 m) long, P&S.

Upper Door Legs: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 24, preformed, IPS, fibre core, wire rope, each 6 ft 6 in. (1.98 m) long, P&S.

Lower Door Legs: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 24, preformed, IPS, fibre core, wire rope, each 6 ft 9 in. (2.06 m) long, P&S.

Attachments

Doors: "A.T. Cameron" and "E.E. Prince" to October 1985: flat, rectangular, wood, metal bound, triple shod, 7 ft 6 in. (2285 mm) long by 4 ft 2 in. (1270 mm) high by 2.5 in. (63.5 mm) thick, each 1000 lb (450 kg) weight, 30 ft² (2.9 m²) area.

"E.E. Prince" since October 1985: I.C. Perfect "normal", size 88, steel, V-doors with solid towing yoke, 7 ft 4 in. (2230 mm) long, 4 ft 4 in. (1320 mm) high, each 805 lb (365 kg) weight, 30 ft² (2.9 m²) area.

Floats: Thirty-four 8-in. (200-mm) diameter, spherical, aluminum, deep sea (average 6.32 lb (2.87 kgf) static buoyancy each and capable of working to 550 fm (1000 m) deep), 14 evenly spaced on bosom (on square between quarters) and 10 evenly spaced on each wing, P&S.

Bobbins: 4 solid rubber rollers, 16 in. (406 mm) outside diameter by 5 in. (127 mm) wide with 2.5-in (63.5-mm) diameter hole, 50 lb (22.7 kg) each, evenly spaced on bosom section of footrope.

6 rubber bunt bobbins ("half eggs"), 14 in. (356 mm) outside diameter by 8 1/2 in. (216 mm) long with 2-in. (51-mm) diameter hole, 26 lb (11.8 kg) each, three evenly spaced on each bunt section (under square) of the footrope, P&S.

13 malleable steel spacers, 8 in. (203 mm) long with 2.5-in. (63.5-mm) diameter bore and toggle chain reaching 14 in. (356 mm) from the spacer center-line, 17 lb (7.7 kg) each, on footrope, 5 evenly spaced on bosom section, 2 on each of the two bunt sections, P&S evenly spaced between the bobbins, 1 on the aft end of each of the four wing sections, P&S.

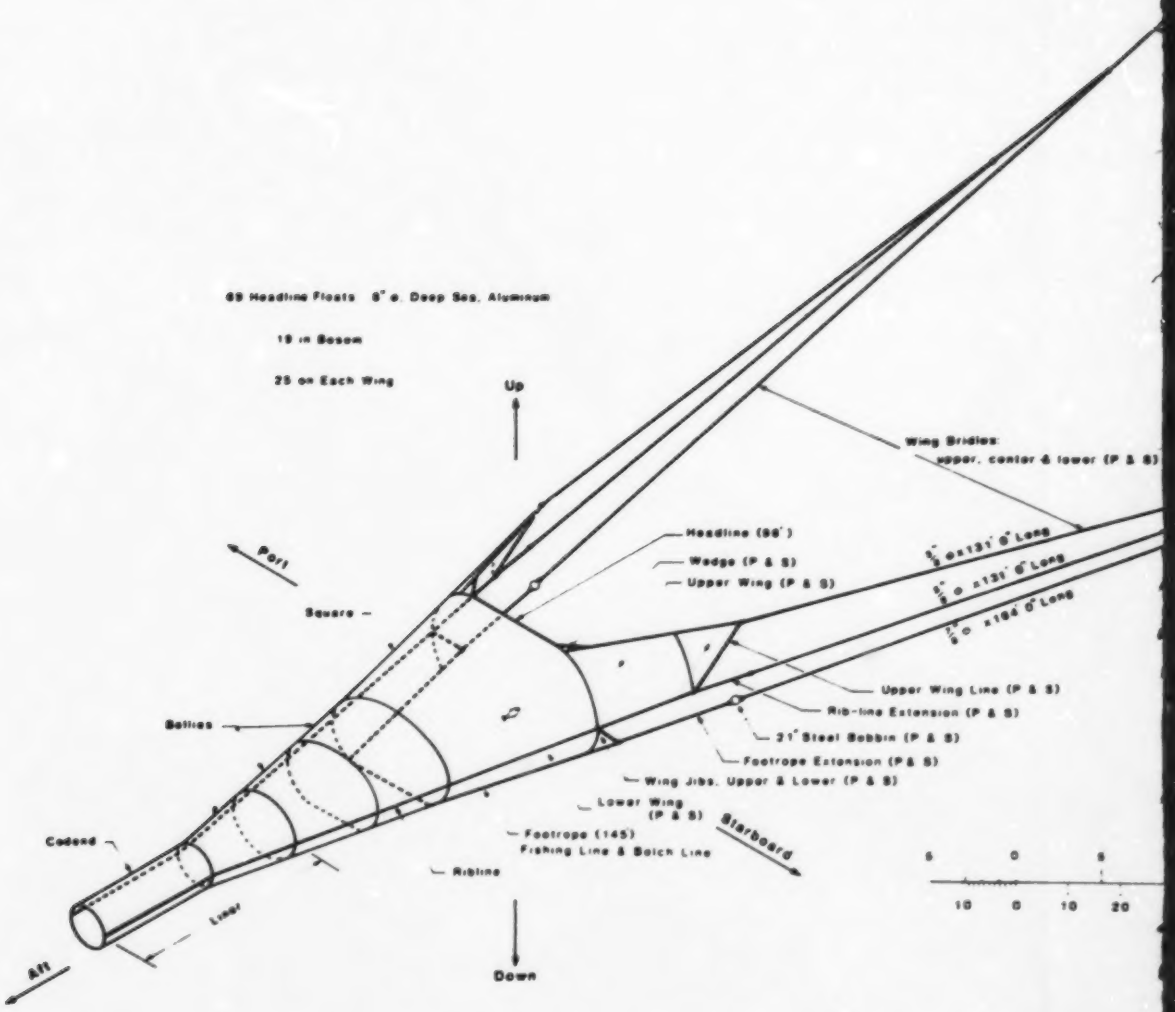
Rubber discs (tire stampings), 7 in. (178 mm) diameter with 2-in. (51-mm) diameter hole sufficient to complete filling the footrope.

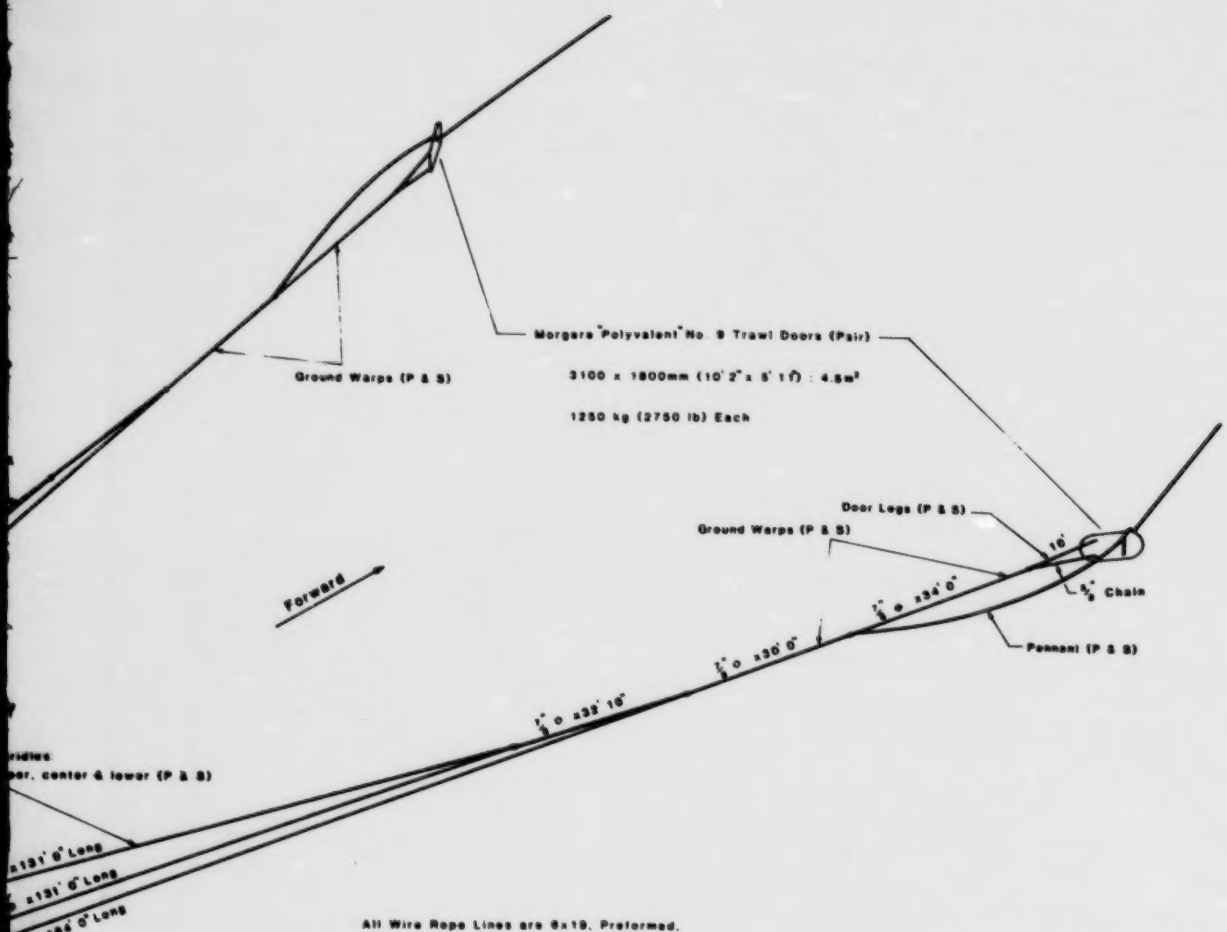
2 banded steel wing bobbins, 14 in. (356 mm) diameter on steel spindle 2 in. (51 mm) diameter by 20 in. (508 mm) long without butterfly, one shackled between each end of the footrope, P&S and the corresponding lower wing bridle.

Chafer: Whole green cowhide covering under side only of the aft half of the codend.

## Engel 145, High-Opening, Groundfish Survey Trawl ( Lady Hammond )

### - Isometric Assembly






All Wire Rope Lines are 6x19, Preformed,
Galvanized, Improved Plow Steel, Fibre Core

All Line Lengths Include Eye Splices

⌀ = Diameter

(P & S) Port and Starboard (Two Pieces - Same Both Sides)

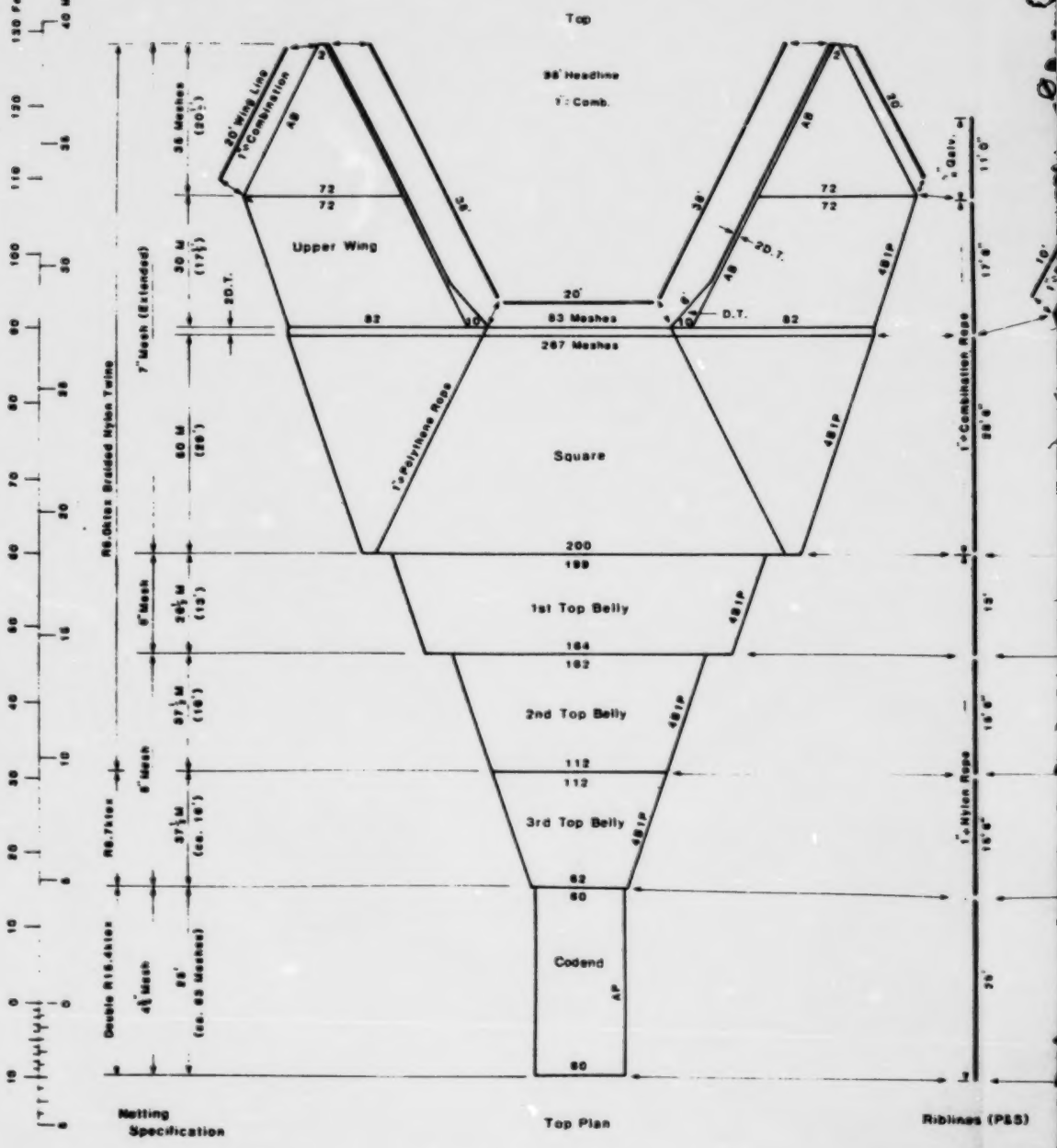
= Sea Bed Under Headline Centre

0 5 10 15 20 25 30 35 40 45 50 Metres

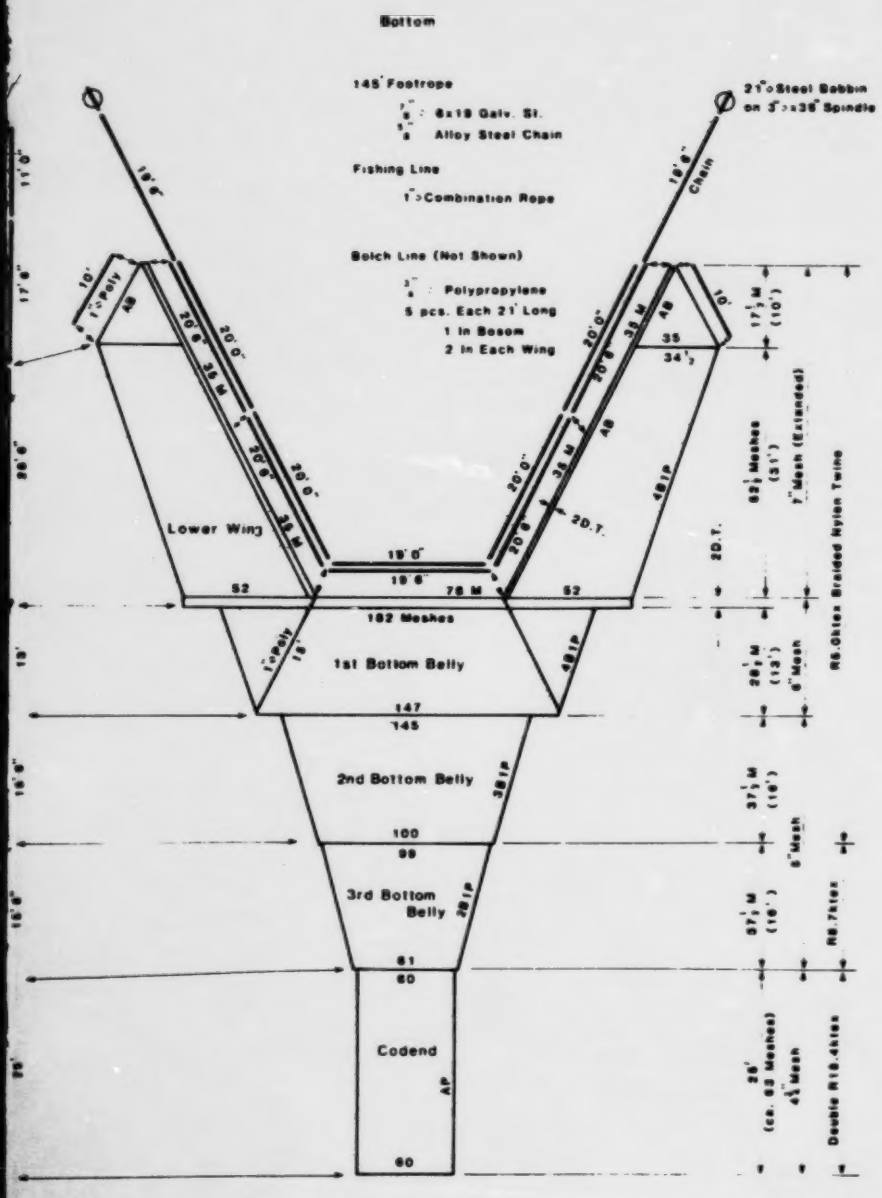
0 0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 Feet

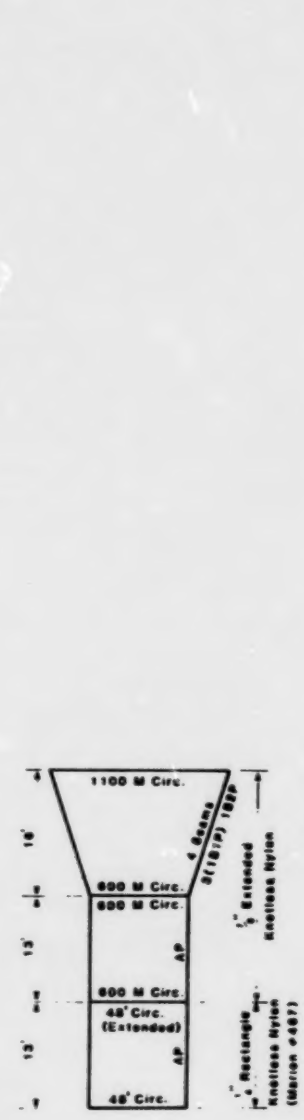
## Engel, 145, High-Opening, Groundfish Survey Trawl (Lady Hammond)

### Trawl Plan of Netting and Frame Lines



mmond)


Bottom
145' Footrope
Fishing Line
1" Combination Rope
Belch Line (Not Shown)
Polypropylene
5 pcs. Each 21' Long
1 In Bosom
2 In Each Wing
Lower Wing
1st Bottom Belly
2nd Bottom Belly
3rd Bottom Belly
Codend
AP
152 Meshes
Bottom Plan

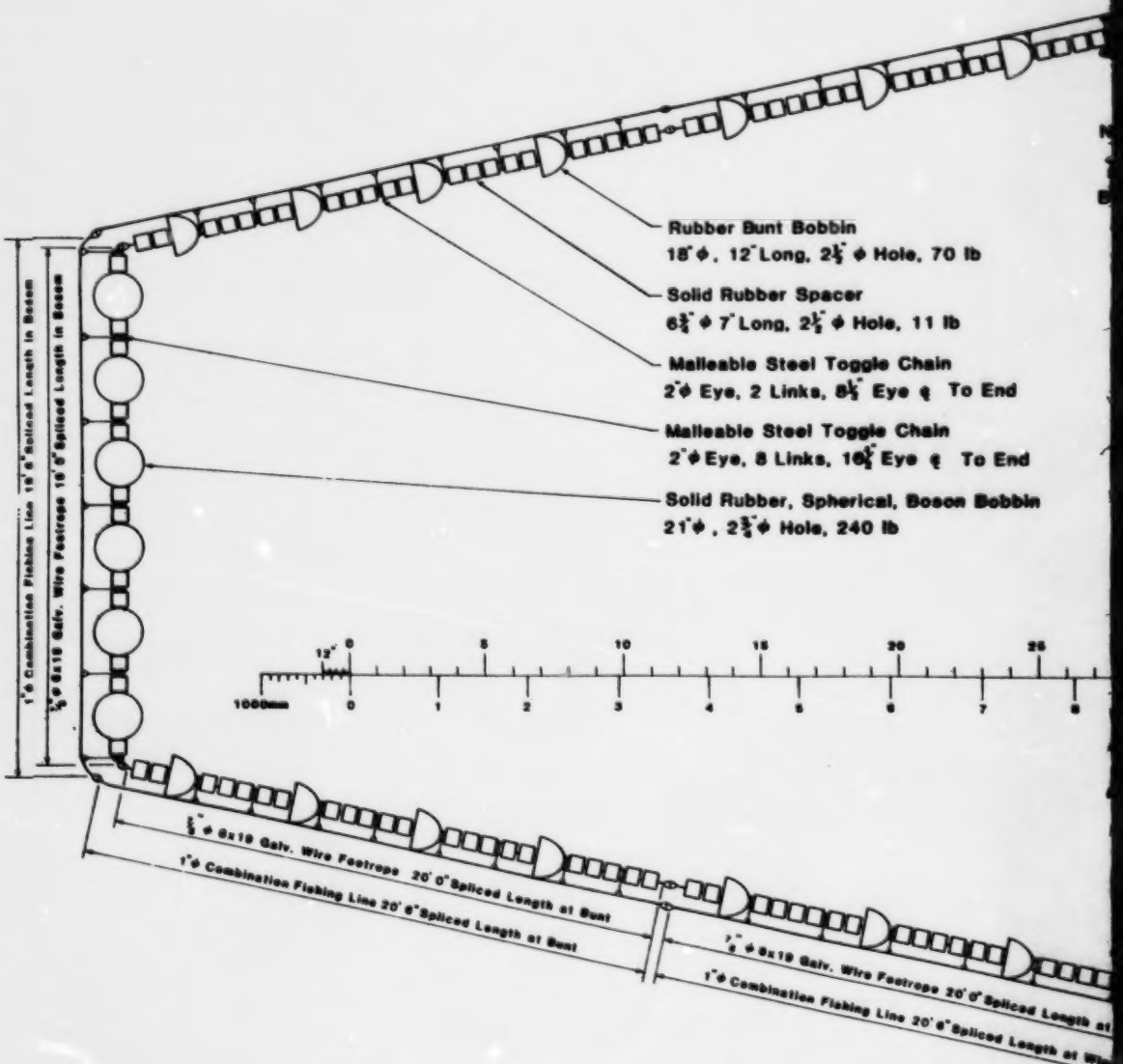

Netting Specification

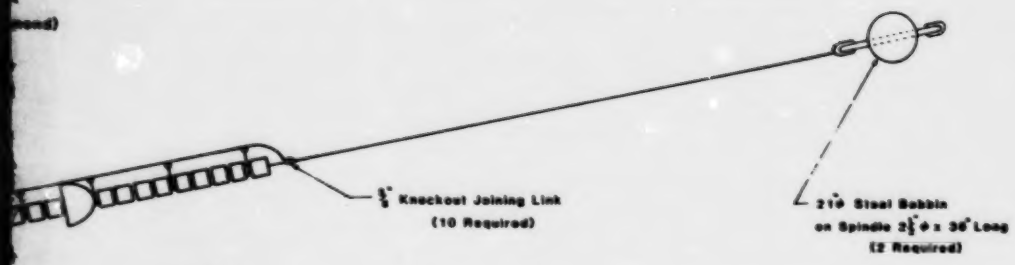

1100 M Circ.
600 M Circ.
600 M Circ.
600 M Circ.
48' Circ. (Extended)
48' Circ.
AP
Liner

(P&S)

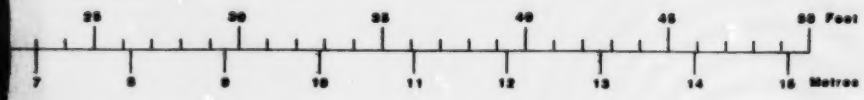
## Engel 145' High-Opening, Groundfish Survey Trawl (Lady Hammond)

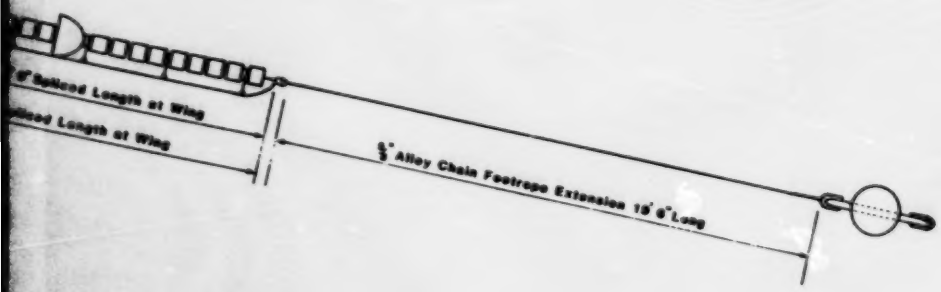
### Footrope and Fishing Line


Rubber Bunt Bobbin
18"ϕ, 12"Long, 2½"ϕ Hole, 70 lb
Solid Rubber Spacer
6¾"ϕ 7"Long, 2½"ϕ Hole, 11 lb
Malleable Steel Toggle Chain
2"ϕ Eye, 2 Links, 8½" Eye ℄ To End
Malleable Steel Toggle Chain
2"ϕ Eye, 8 Links, 16¾" Eye ℄ To End
Solid Rubber, Spherical, Boson Bobbin
21"ϕ, 2¾"ϕ Hole, 240 lb
1"ϕ Combination Fishing Line 19'6"Spliced Length in Boson
⅝"ϕ 6x19 Galv. Wire Footrope 19'0"Spliced Length in Boson
⅝"ϕ 6x19 Galv. Wire Footrope 20'0"Spliced Length at Bunt
1"ϕ Combination Fishing Line 20'6"Spliced Length at Bunt
⅝"ϕ 6x19 Galv. Wire Footrope 20'0"Spliced Length at
1"ϕ Combination Fishing Line 20'6"Spliced Length at Wi




| | Number In Bosom | In Each Bunt | In Each Wing | Total In Net |
|---|---|---|---|---|
| lb | 0 | 4 | 3 | 14 |
| | 12 | 22 | 23 | 102 |
| o End | 0 | 8 | 7 | 30 |
| To End | 7 | 0 | 0 | 7 |
| Bobbin | 6 | 0 | 0 | 6 |



ENGEL, 145-FT, HIGH-LIFT, SURVEY TRAWL ("LADY HAMMOND")

Netting Panels:

| Part name | No. of pieces | Material | Twine weight | Mesh length (extended) | Number of meshes Wide Fore | Wide Aft | Deep | Taper cycle |
|---|---|---|---|---|---|---|---|---|
| Upper wing jib | 2 | Braided nylon | R5000 tex | 7" (180 mm) | 2 (plus 2 meshes double twine at headline) | 72 | 35 | AB headline AB wingline |
| Upper wing | 2 | " | " | " | 72 (plus 2 meshes double twine at headline) | 82 | 30 | AB headline 4B1P ribline |
| Wedge | 2 | " | Double R5000 tex | " | 2 | 10 | 10 | 3B1T + 2B1T headline AB wing |
| Square | 1 | " | R5000 tex | " | 267 (plus 2 meshes double twine on fore edge) | 200 | 50 | 4B1P both ribs |
| Lower wing jib | 2 | " | " | " | 0 (plus 2 meshes double twine at bolch line) | 35 | 17½ | AB bolch line AB wingline |
| Lower wing | 2 | " | " | " | 34½ (plus 2 meshes double twine at bolch line) | 52 | 52½ | AB bolch line 4B1P ribline |
| 1st top belly (fore) | 1 | " | " | 6" (150 mm) | 199 | 164 | 26½ | 4B1P both ribs |
| 2nd top belly (centre) | 1 | " | " | 5" (130 mm) | 162 | 112 | 37½ | " |
| 3rd top belly (aft) | 1 | " | R8700 tex | " | 112 | 62 | 37½ | " |
| 1st lower belly (fore) | 1 | " | R5000 tex | 6" (150 mm) | 182 | 147 | 26½ | " |
| 2nd lower belly (centre) | 1 | " | " | 5" (130 mm) | 145 (plus 2 meshes double twine on fore edge) | 100 | 37½ | 3B1P both ribs |
| 3rd lower belly (aft) | 1 | " | R8700 tex | " | 99 | 61 | 37½ | 2B1P both ribs |
| Codend | 2 | " | Double R15400 tex | 4¾" (120 mm) | 60 | 60 | 25 ft | AP both ribs |
| 3rd belly liner | 4 | Knotless nylon | R425 tex | 7/8" | 275 | 150 | 220 | 3(1B1P) + 1B2P both sides |
| Fore codend liner | 1 | " | " | " | 600 | 600 | 180 | AP both sides |
| Aft codend liner | 1 | " | - | 1/4" rect. | 48' circum. | | 13 ft | Square (Marion #467) |

ENGEL 145-ft (cont'd)

Frame lines

Note: All line lengths are spliced lengths.

Headline: 3 pieces 1 in. (26 mm) diameter combination (wire and manila) rope, one 20 ft 0 in. (6.10 m) long in bosom between upper quarters, two each 38 ft 0 in. (11.58 m) long on wings, port and starboard (P&S), 96 ft 0 in. (29.25 m) total length.

Upper wing lines: 2 pieces 1 in. (26 mm) diameter combination rope, each 20 ft 0 in. (6.10 m) long, on the lower edge of the respective, upper wing jibs, P&S.

Lower wing lines: 2 pieces 1 in. (26 mm) diameter laid polypropylene, each 10 ft 0 in. (3.05 m) long, on the upper edge of the respective lower wing jibs, P&S.

Rib lines: 8 pieces 1 in. (26 mm) diameter nylon rope, two each 13 ft 0 in. (3.96 m) spliced length on the ribs of the 1st belly, P&S, four each 15 ft 6 in. (4.72 m) long on the ribs of the 2nd and 3rd bellies, respectively, P&S, two each 25 ft 0 in. (7.62 m) long on the codend ribs, P&S.

4 pieces 1 in. (26 mm) diameter combination rope, two each 28 ft 6 in. (8.69 m) long on the ribs of the square and lower wings, P&S, two each 17 ft 6 in. (5.33 m) long on the lower (outer) edge of the upper wings. Total length 115 ft 0 in. (35.05 m) each, P&S.

Rib-line extension: 2 pieces 5/8 in. (16 mm) diameter galvanized, 6 x 19, preformed, improved plow steel (IPS), fibre core, wire rope, each 11 ft 0 in. (3.35 m) long, between the forward end of the rib line and centre wing bridle, P&S.

Bolch line: 5 pieces 3/4" (20 mm) diameter polypropylene rope, each 21 ft 0 in. (6.40 m) long, one in the lower bosom between the quarters and two on the inner edge of each lower wing from the quarter to the jib tip, P&S. Total length 105 ft 0 in. (32 m).

Fishing line: 5 pieces 1 in. (26 mm) diameter combination rope, one 19 ft 6 in. (5.94 m) long in bosom and four each 20 ft 6 in. (6.25 m) long, two on each lower wing from the quarter to the jib tip, P&S. Total length 101 ft 6 in. (30.94 m).

Footrope: 5 pieces 7/8 in. (22 mm) diameter galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, one 19 ft 0 in. (5.79 m) long in the bosom and four each 20 ft 0 in. (6.10 m) long, two on each wing, P&S. Total length 99 ft 0 in. (30.18 m).

Footrope extension: 2 pieces 5/8" (16 mm) alloy chain, each 19 ft 6 in. (5.94 m) long, between the lower wing end and the wing bobbin, P&S.

Running Lines

Upper wing bridles: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 19, preformed, improved plow steel (IPS), fibre core wire rope, each 131 ft 0 in. (39.93 m) long, port and starboard (P&S).

Center wing bridles: Same as upper wing bridles.

Upper bridle extensions: 2 pieces 7/8 in. (22 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core wire rope, each 32 ft 10 in. (10.01 m) long connecting the fore ends of the upper and center wing bridles with the aft end of the ground warp, P&S.

Lower wing bridles: 2 pieces 7/8 in. (22 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, each 164 ft 0 in. (49.99 m) long, P&S.

Ground warps: 4 pieces 7/8 in. (22 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, the two aft pieces P&S each 30 ft 0 in. (9.14 m) long and the two fore pieces P&S each 34 ft 0 in. (10.36 m) long.

Door legs: 4 pieces 5/8 in. (16 mm) alloy chain, each 10 ft 0 in. (3.05 m) long, two on each door, P&S.

Pennants: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, each 54 ft 6 in. (16.61 m) long, P&S.

Attachments

Doors: Morgère, "polyvalent", No. 9, 10 ft 2 in. (3100 mm) long by 5 ft 11 in. (1800 mm) high, each 2750 lb (1250 kg) weight, 50 ft² (4.5 m²) area.

Floats: Sixty-nine 8-in. (200-mm) diameter, spherical, cast aluminum, deep sea (average 6.32 lb (2.87 kgf) static buoyancy each and capable of working to 550 fm (1000 m) deep), 19 evenly spaced on bosom (square) and 25 evenly spaced on each wing, P&S, of the headline.

Bobbins: 6 solid rubber spherical bosom bobbins, 21 in. (533 mm) outside diameter, 2¾ in. (70 mm) diameter hole, 240 lb (109 kg) each, evenly spaced on bosom section of footrope.

14 rubber bunt bobbins ("half eggs"), 18 in. (460 mm) diameter, by 12 in. (305 mm) long with 2.5 in. (63.5 mm) hole, 70 lb (32 kg) each, four evenly spaced on each bunt section of the footrope, P&S, and three evenly spaced on each wing section of the footrope, P&S.

37 toggle chains with 2 in. (51 mm) inside diameter malleable steel eye, seven with 8 links reaching 16½ in. (419 mm) from the center of eye, evenly spaced on bosom section of footrope, 30 with 2 links reaching 8½ in. (216 mm) from the center of eye, 8 on each bunt section of the footrope, P&S, and 7 on each wing section of the footrope, P&S.

ENGEL 145-ft (cont'd)

102 solid rubber spacers, 7 in. (178 mm) long, 6¾ in. (171 mm) outside diameter, 2½ in. (63.5 mm) bore, each weighing 11 lb (5 kg), 12 in bosom, 22 in each bunt, P&S, and 23 in each wing, P&S.

2 spherical steel wing bobbins, 21 in. (533 mm) outside diameter, each on a steel spindle 2½ in. (63.5 mm) diameter by 36 in. (915 mm) long, shackled between the footrope extension and lower wing bridle, P&S.

## Atlantic Western II A Groundfish Survey Trawl ( Lady Hammond and Alfred Ne
## - Isometric Assembly

88 Headline Floats : 8" ϕ, Deep Sea, Aluminum

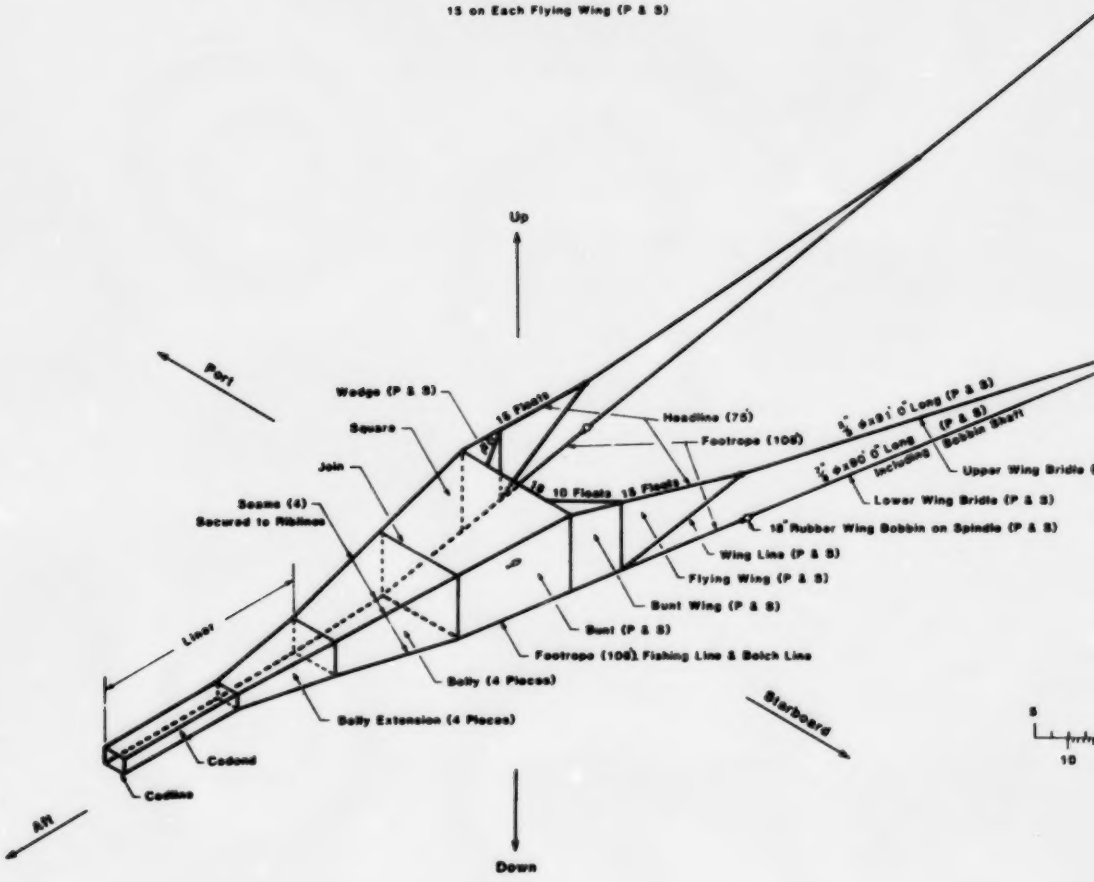
Static Buoyancy 8.32 lb (2.87 kg) Each

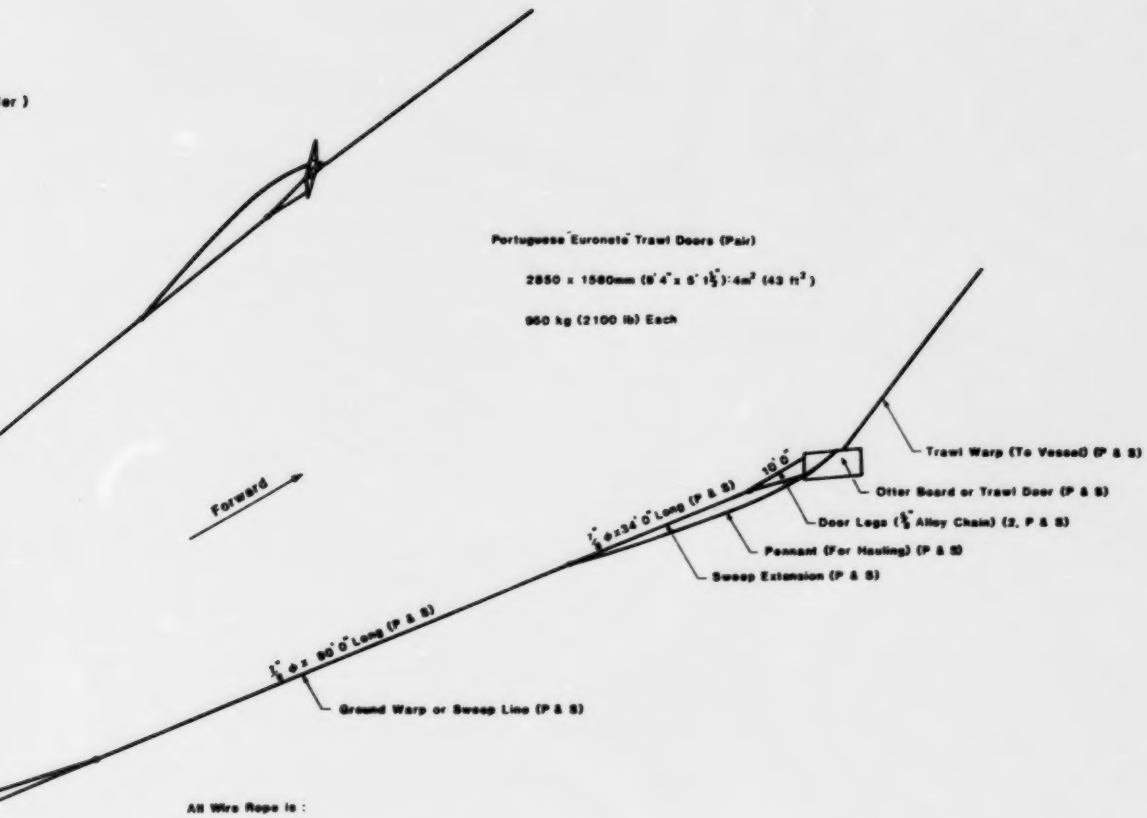
Working Depth to 550 fm (1000m)

18 on Bosom

10 on Each Wedge (P & S)

15 on Each Flying Wing (P & S)




Portuguese 'Euronete' Trawl Doors (Pair)
2850 x 1560mm (9'4" x 5' 1⅛"):4m² (43 ft²)
960 kg (2100 lb) Each
Trawl Warp (To Vessel) (P & S)
Otter Board or Trawl Door (P & S)
Door Legs (⅝" Alloy Chain) (2, P & S)
Pennant (For Hauling) (P & S)
Sweep Extension (P & S)
Ground Warp or Sweep Line (P & S)
Forward

All Wire Rope is :

6 x 19 Preformed , Galvanized,

Improved Plow Steel, Fibre Core

All Line Lengths Include Eye Splices

Φ = Diameter

(P & S)= Port and Starboard (Two Pieces - Same Both Sides)

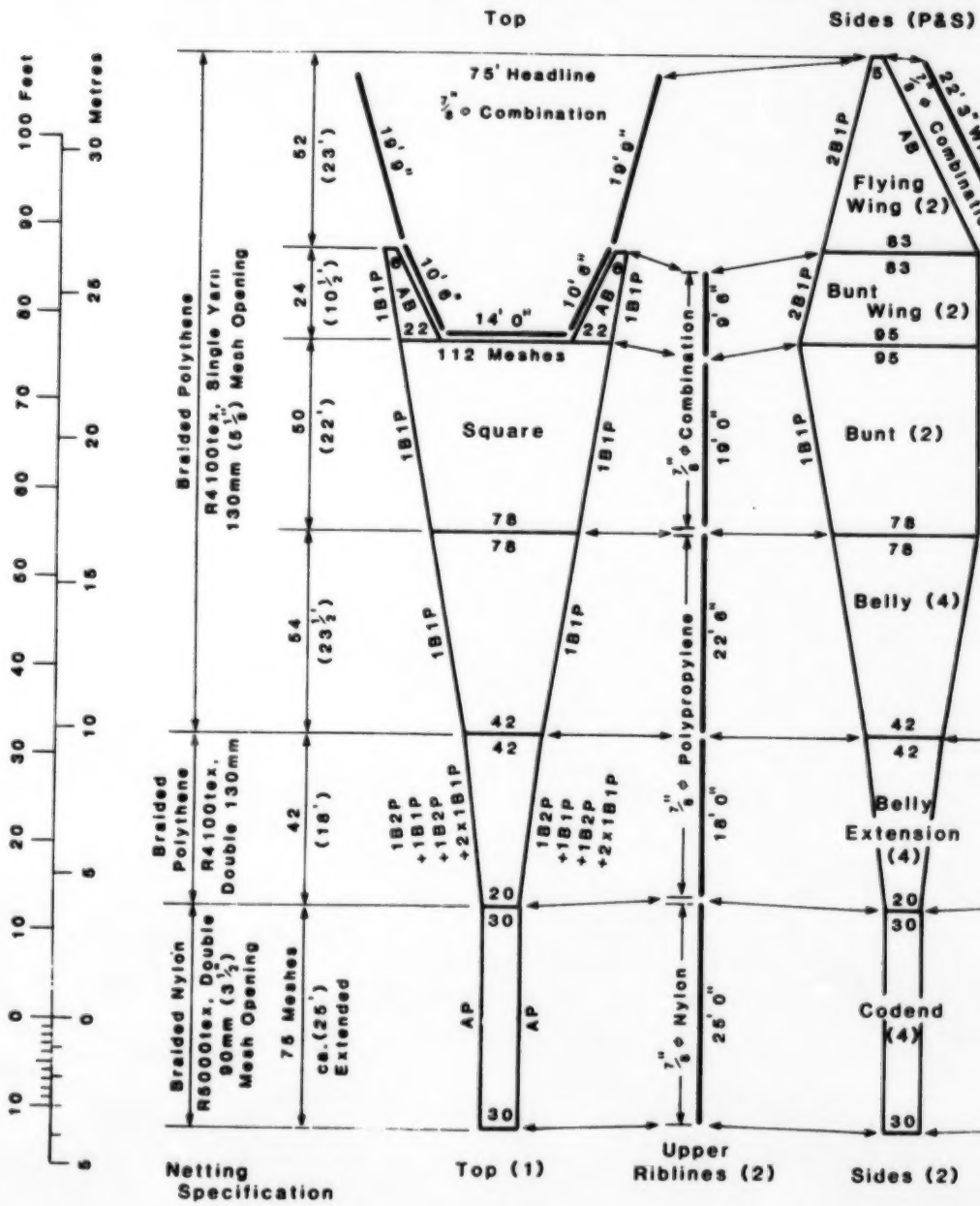
⇐⇒ = Sea Bed Under Centre of Headline

0 5 10 15 20 25 30 35 40 45 50 Metres

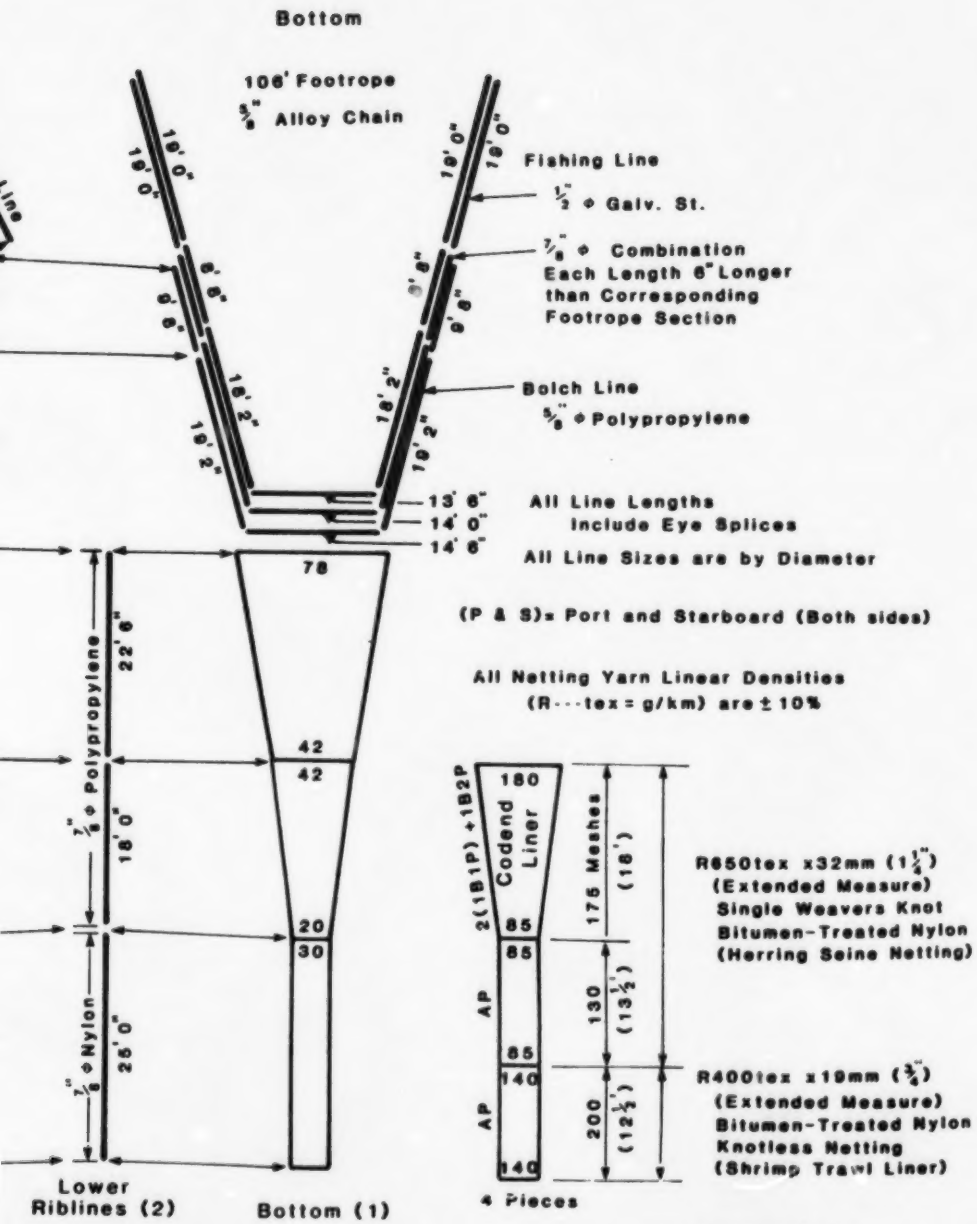
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 Feet

# Atlantic Western II A Groundfish Survey

## Trawl Plan of Netting and Frame Lines



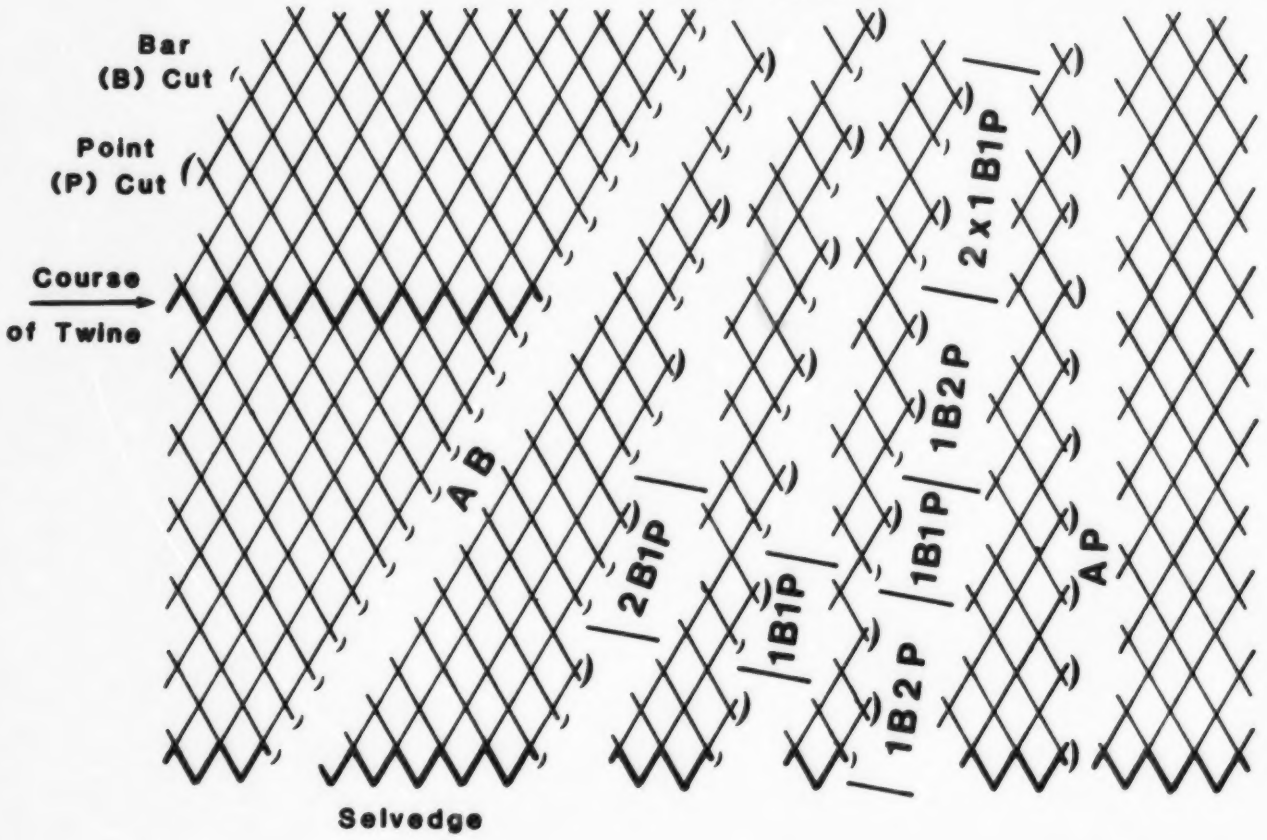
# Trawl




Liner Specification

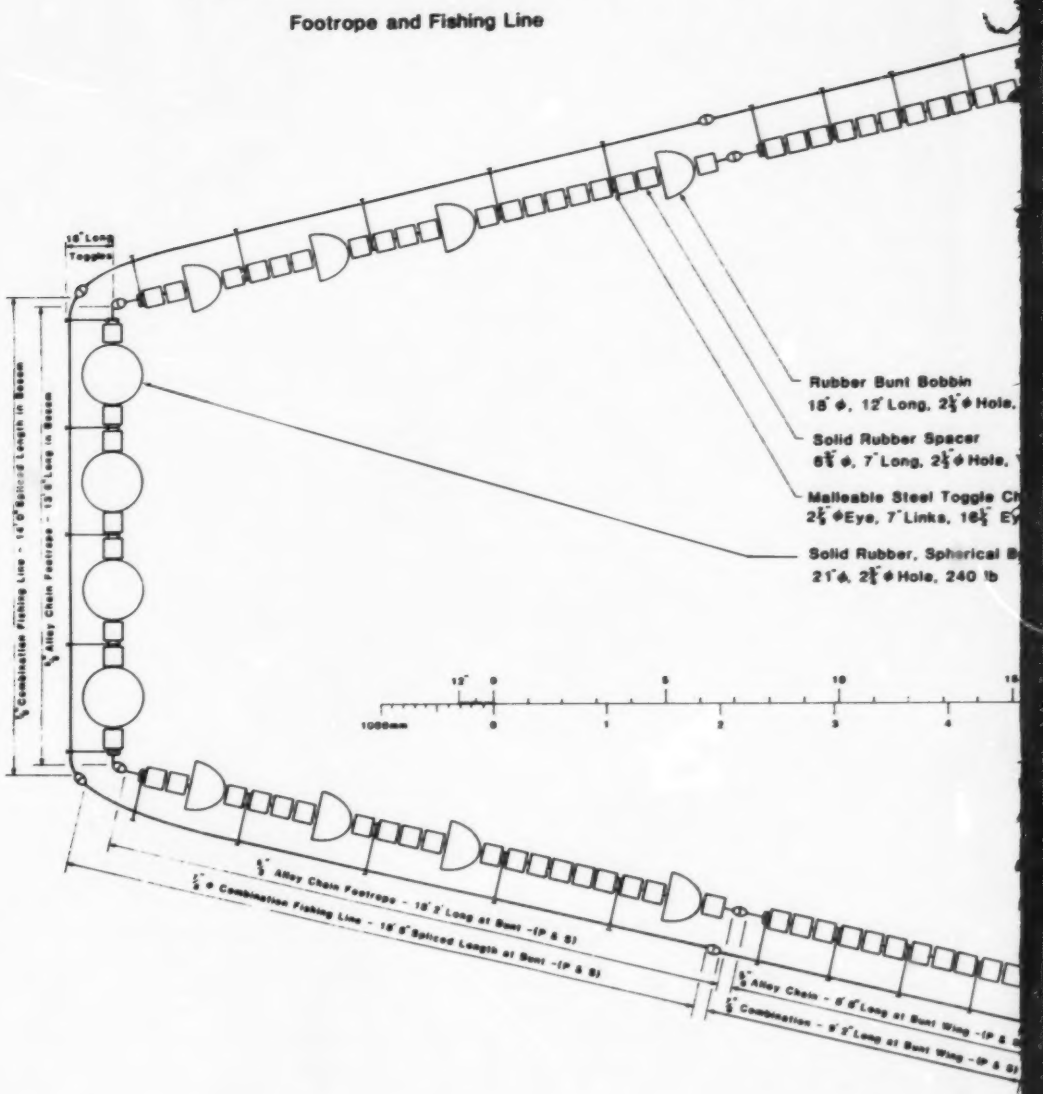
## Atlantic Western II A Groundfish Survey Trawl

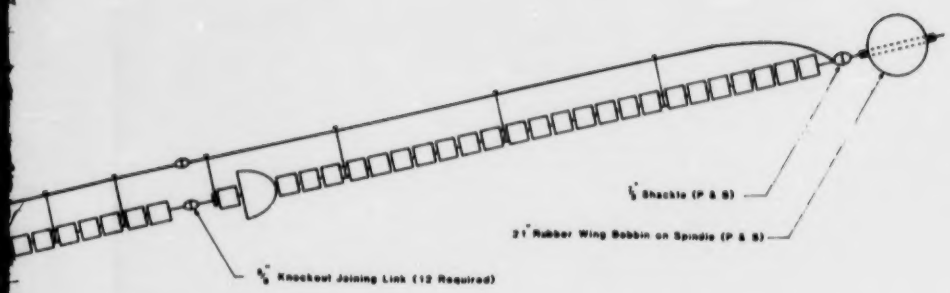
### Taper Cutting Cycles



**Atlantic Western IIA Groundfish Survey Trawl**

**Footrope and Fishing Line**

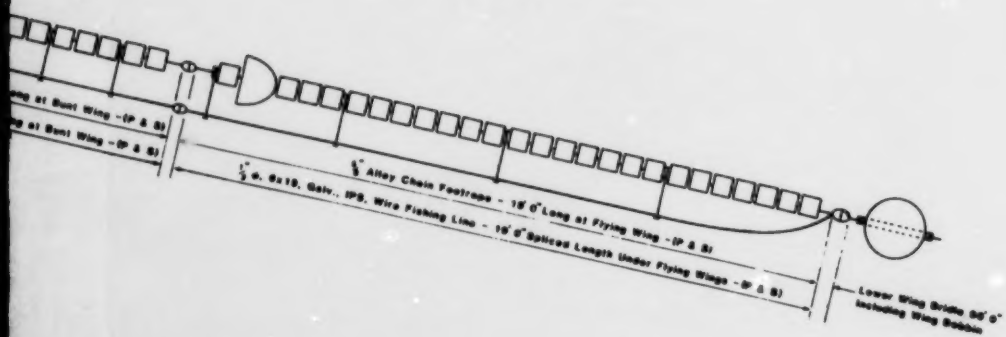

18" Long Toggles
Rubber Bunt Bobbin
18" ϕ, 12" Long, 2½" ϕ Hole,
Solid Rubber Spacer
8½" ϕ, 7" Long, 2½" ϕ Hole,
Malleable Steel Toggle Ch
2½" ϕ Eye, 7" Links, 16½" Ey
Solid Rubber, Spherical B
21" ϕ, 2½" ϕ Hole, 240 lb
15" 0 5 10
1000mm 0 1 2 3 4
⅝" ϕ Combination Fishing Line - 14'0" Spliced Length in Bosom
⅝" Alloy Chain Footrope - 13'6" Long in Bosom
⅝" Alloy Chain Footrope - 15'3" Long at Bunt -(P & S)
⅝" ϕ Combination Fishing Line - 15'6" Spliced Length at Bunt -(P & S)
⅝" Alloy Chain - 6'6" Long at Bunt Wing -(P & S)
⅝" Combination - 9'3" Long at Bunt Wing -(P & S)




| | Number In Bosom | In Each Bunt | In Bunt Wing | In Flying Wing | Total In Net |
|---|---|---|---|---|---|
| r Bunt Bobbin<br>2" Long, 2½" ϕ Hole, 70 lb | 0 | 4 | 0 | 1 | 10 |
| Rubber Spacer<br>7" Long, 2½" ϕ Hole, 11 lb | 8 | 19 | 11 | 25 | 118 |
| ble Steel Toggle Chain<br>ye, 7" Links, 16½" Eye ϕ To End | 5 | 5 | 4 | 4 | 31 |
| Rubber, Spherical Bosom Bobbin<br>2½" ϕ Hole, 240 lb | 4 | 0 | 0 | 0 | 4 |

(P & S) = Port and Starboard, I.E., The Same on Both Sides of the Net
ϕ = Diameter

All Line Lengths Include Eye Splices


ng at Bunt Wing - (P & S)
g at Bunt Wing - (P & S)
⅜" Alloy Chain Footrope - 15' 0" Long at Flying Wing - (P & S)
⅜" ϕ, 6x19, Galv., IPS, Wire Fishing Line - 15' 0" Spliced Length Under Flying Wings - (P & S)
Lower Wing Bridle 64' 0" Including Wing Bobbin

# ATLANTIC WESTERN IIA, BOX, SURVEY TRAWL

## Netting Panels:

| Part name | No. of pieces | Material | Twine weight | Mesh length (extended) | Number of meshes Wide Fore | Wide Aft | Deep | Taper cycle |
|---|---|---|---|---|---|---|---|---|
| Flying wing | 2 | Braided polyethylene | R4100 tex | 5 1/8" (130 mm) | 5 | 83 | 52 | 2B1P top<br>AB bottom |
| Bunt wing | 2 | " | " | " | 83 | 95 | 24 | 2B1P top<br>AP bottom |
| Bunt | 2 | " | " | " | 95 | 78 | 50 | 1B1P top<br>AP bottom |
| Wedge | 2 | " | " | " | 6 | 22 | 24 | AB inner<br>1B1P outer |
| Square | 1 | " | " | " | 112 | 78 | 50 | 1B1P both |
| Fore belly | 4 | " | " | " | 78 | 42 | 54 | 1B1P both |
| Aft belly | 4 | " | Double R4100 tex | " | 42 | 20 | 42 | 2 x 1B2P<br>+ 3 x 1B1P |
| Codend | 4 | Braided nylon | Double R5000 tex | 3½" (90 mm) opening | 30 | 30 | 75 | AP both |
| Aft belly liner | 2 | Bitumen-treated knotted nylon | R650 tex | 1¼" (32 mm) | 180 | 85 | 175 | 2 x 1B1P<br>+ 1B2P |
| Fore codend liner | 2 | " | " | " | 85 | 85 | 130 | AP both |
| Aft codend liner | 2 | Bitumen-treated knotless nylon | R400 tex | ¾" (19 mm) | 140 | 140 | 200 | AP both |

## Frame lines

Note: All line lengths are spliced lengths.

Headline: 5 pieces, 7/8 in. (22 mm) diameter combination (wire and manila) rope, one 14 ft 0 in. (4.27 m) long in the bosom, two each 10 ft 6 in. (3.20 m) long on the wedges and two each 19 ft 9 in. (6.02 m) long on the flying wings, total length 75 ft (23 m).

Wing lines: 2 pieces, 7/8 in. (22 mm) diameter combination wire and manila rope, each 22 ft 3 in. (6.78 m) long on the flying wings.

Bolch line: 5 pieces, 5/8 in. (16 mm) diameter polypropylene rope, one 14 ft 6 in. (4.42 m) long in the bosom, two each 19 ft 2 in. (5.84 m) long on the bunts, and two each 9 ft 8 in. (2.95 m) long on the bunt wings, total length 73 ft (22¼ m).

Fishing line: 5 pieces, 7/8 in. (22 mm) diameter combination rope, one 14 ft 0 in. (4.27 m) long in the bosom, two each 18 ft 8 in. (5.69 m) long on the bunts and two each 9 ft 2 in. (2.79 m) long on the bunt wings.

2 pieces, 1/2 in. (13 mm) diameter, 6 x 19, galvanized, preformed, improved plow steel (IPS), fibre core wire rope each 19 ft 0 in. (5.79 m) long under the flying wings, total length 108 ft (33 m).

Footrope: 7 pieces, 5/8 in. (16 mm) alloy chain, one 13 ft 6 in. (4.11 m) long in the bosom, two each 18 ft 2 in. (5.54 m) long in the bunts, two each 8 ft 8 in. (2.64 m) long in the bunt wings and two each 19 ft 0 in. (5.79 m) long under the flying wings, total length 106 ft (32.3 m).

Riblines: 4 pieces, 7/8 in. (22 mm) diameter combination rope, two each 9 ft 6 in. (2.90 m) long at the wedge/bunt-wing ribs, two each 19 ft 0 in. (5.79 m) long at the square/bunt ribs.

8 pieces, 7/8 in. (22 mm) diameter polypropylene rope, four each 22 ft 6 in. (6.86 m) long on the four belly ribs and four each 18 ft 0 in. (5.49 m) long on the four belly extension ribs.

4 pieces, 7/8 in. (22 mm) diameter nylon rope, each 25 ft 0 in. (7.62 m) long, on the four codend ribs.

Total length 65 ft 6 in. (20.0 m) on lower ribs and 94 ft 0 in. (28.7 m) on upper ribs.

## Running Lines

Upper wing bridles: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 19, preformed, improved plow steel (IPS), fibre core, wire rope, each 91 ft 0 in. (27.74 m) spliced length, port and starboard (P&S).

ATLANTIC WESTERN IIA (cont'd)

Lower wing bridles: 2 pieces 7/8 in. (22 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, each 90 ft 0 in. (27.43 m) long including splices and wing bobbin, P&S.

Ground warps: 4 pieces 7/8 in. (22 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, two aft pieces P&S each 90 ft 0 in (27.43 m) long and two fore pieces P&S each 34 ft 0 in (10.36 m) long.

Pennants: 2 pieces 5/8 in. (16 mm) diameter, galvanized, 6 x 19, preformed, IPS, fibre core, wire rope, each 53 ft 6 in. (16.31 m) long, P&S.

Door legs: 4 pieces 5/8 in. (16 mm) alloy chain, each 10 ft 0 in. (3.05 m) long, two on each door, P&S.

Attachments

Doors: Portuguese "Euronete", round-nose, slotted, slightly cambered, steel, 9 ft 4 in. (2850 mm) long by 5 ft 1 in. (1560 mm) high, each 2100 lb (950 kg) weight, 43 ft² (4 m²) area.

Floats: Sixty-eight 8-in. (220 mm) diameter, spherical, aluminum, deep sea (average 6.32 lb (2.87 kgf) static buoyancy each and capable of working to 550 fm (1000 m) deep), 18 evenly spaced on bosom (square), 10 evenly spaced on each wedge P&S and 15 evenly spaced on each flying wing P&S, siezed on headline.

Bobbins: 4 solid rubber spherical bosom bobbins, 21 in. (533 mm) outside diameter with 2.75 in. (70 mm) diameter hole, 240 lb (110 kg) each, evenly spaced on bosom section of footrope.

10 rubber bunt bobbins ("half eggs"), 18 in. (460 mm) outside diameter by 12 in. (305 mm) long with 2.5 in. (63.5 mm) diameter hole, 70 lb (32 kg) each, four on each bunt section and one near the aft end of each flying wing (forward) section of the footrope, P&S.

31 toggle chains with 2 7/8 in. (73 mm) inside diameter malleable steel eye, 7-link reaching 16.5 in. (420 mm) from center of the eye, on footrope, 5 evenly spaced on bosom section, 5 evenly spaced on each bunt section, 4 evenly spaced on each bunt-wing section and 4 evenly spaced on each flying wing section.

118 solid rubber spacers, 7 in. (178 mm) long by 6.75 in. (172 mm) outside diameter with 2.5 in. (64 mm) diameter bore, 11 lb (5 kg) each, on footrope, 8 in bosom section, 19 in each bunt section, P&S, 11 in each bunt-wing section, P&S, and 25 in each flying wing section, P&S.

2 solid rubber spherical wing bobbins, 21 in. (535 mm) outside diameter with 2.75 in. (70 mm) bore, on steel bobbin spindle 26.5 in. (675 mm) long by 2 5/8 in. (67 mm) diameter with 1¼ in. (32 mm) V-shackles both ends, one on aft end of each lower wing bridle, P&S.

Shackles: Twelve 5/8 in. (16 mm) knockout joining links connecting sections of footrope and fishing line, respectively.

Two 7/8 in. (22 mm) knockout joining links securing forward ends of footrope and fishing line to wing-bobbin spindles, P&S.

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